

THE THREAD AGENCY,
NEW YORK

300 WEST 39TH STREET
NEW YORK, N. Y.

NEW YORK
October 29, 1919

Division Castings Company
10 West Street
New York City

Gentlemen: Re: Order 888978 -- Elcott Cooke Willimantic

You will recall that in connection with the above
Elcott Cooke Willimantic account for the American Thread Company's Willimantic
other the same would stand up under some rather severe opera-
in conditions. As the mail has been found entirely satisfac-
tory, we are contemplating the purchase of 18 additional mat-
erial would inquire at what price and just how soon this
shipment is every respect. of course, to duplicate

Yours truly,

The Thread Agency
Asst. Purchasing Agent

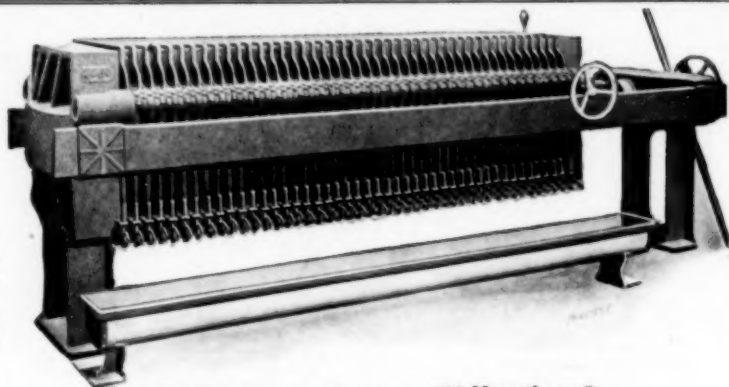
**For Big Production and Low
Operating Cost**

**SHRIVER
FILTER PRESSES**

They increase output and effect marked savings in filter cloth replacements and the recovery of values. Little attendance and less wash water adds to their economy.

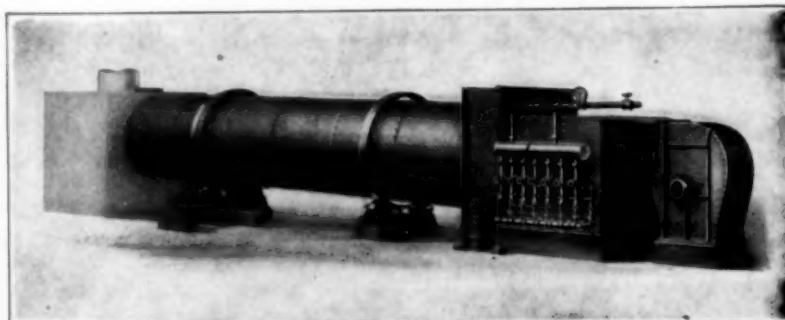
Have wide joint surfaces. Accurate finishing of plates and frames, coupled with an efficient tightening device, prevents leakage.

Presses for all industrial filtration. Small presses for laboratory work.



T. Shriver & Co., 808 Hamilton St.
Harrison, N. J.

STEAM HEATED AIR DRYERS



for drying Borax, Nitrate of Ammonia, Baking Powder, etc.

Have equipped largest chemical plants in the world.

Also Direct Heat Dryers for By-Products.

Material carried in stock for standard sizes.

American Process Co.
68 William St., New York

WHEN IN THE MARKET

**Don't Forget that We Supply
the Following Metals and Alloys**

Ferro-Titanium, 25% Ti
Chromium, 98-99% Cr
Ferro-Chromium, 60% Cr
Ferro-Vanadium, 40% Va
Ferro-Molybdenum, 80% Mo
Cobalt, 97%
Tungsten, 95%
Ferro-Tungsten, 70%

Manganese, Pure
Manganese-Copper, 30/70%
Manganese-Titanium, 30% Ti
Manganese-Aluminum, 25% Mn
Phosphor-Copper, 1% Phos
Silicon-Copper, 10% Si
Phosphor-Tin, 5% Phos
Nickel-Copper, 50/50%

We are also in a position to quote on 50% Electro Furnace Ferro-Silicon manufactured by the Keokuk Electro Metals Company, of Keokuk, Iowa. This plant is now turning out a very high grade alloy, and, being centrally located, offers superior shipping facilities and freight rates. We represent this Company as exclusive selling agents.

Foundries making Brass, Bronze, German Silver, Nickel, Aluminum or composition castings should be sure to investigate our Pure Manganese and Manganese Alloys.

Ask for our pamphlet No. 2041.

METAL & THERMIT CORPORATION

Successors to Goldschmidt Detinning Co. and Goldschmidt Thermit Co.

THE EQUITABLE BUILDING, 120 BROADWAY, NEW YORK

San Francisco
329-333 Folsom St.

Chicago
7300 So. Chicago Ave.

Pittsburgh
1427-1429 Western Ave.

Toronto, Ont.
103 Richmond St., W.

Factories located at Chrome, N. J.; Wyandotte, Mich.; East Chicago, Ind., and Jersey City, N. J.

Metallurgical and Chemical Engineering

A consolidation of ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

Discipline

Tenth Avenue at 36th Street
NEW YORK

JAMES H. MCGRAW, President
ARTHUR J. BALDWIN, Treasurer E. J. MEHREN, Vice President
JAMES H. MCGRAW, JR., Secretary

TELEPHONE, 2840 GREELEY. CABLE ADDRESS, MACHINIST, New York

WASHINGTON, 1410 H St., N. W. SALT LAKE CITY, Newhouse Bldg.
CHICAGO, Old Colony Bldg. PHILADELPHIA, Real Estate Trust Bldg.
SAN FRANCISCO, Hialto Bldg. CLEVELAND, Leader-News Bldg.
LONDON, Hastings House, Norfolk St., Strand

H. C. PARMELEE, Managing Editor
ELLWOOD HENDRICK, Consulting Editor
ERNEST E. THUM, Western Editor
R. C. BERGEN, Assistant Editor

J. MALCOLM MUIR, Manager

Yearly subscription price for United States, Mexico and United States dependencies, \$3; all other countries, \$4. Single Copy, 25c. When change of address is ordered, the new and the old addresses must be given. Notice must be received at least 10 days before change takes place. No back copies for more than three months.

Copyright, 1918. Entered as Second-Class Matter at the Post Office at New York, N. Y., under the Act of Congress, Mar. 3, 1879.

Circulation of this issue 11,800 copies

CONTENTS for March 1, 1918

Volume XVIII, Number 5

EDITORIAL:

Discipline	221
A Little Homily on the Tariff	221
The Chemical Alliance	222
Competition in Steel After the War	223
Factors in World Trade Competition	224
The Administration Water-Power Bill	225
New Western Office of METALLURGICAL AND CHEMICAL ENGINEERING	226
Coming Meetings and Events	226
New York Meeting of the American Institute of Mining Engineers	227
Spring Meeting of the American Electrochemical Society	231
Engineers in Government Service	231
Ultraviolet Energy and Its Use. By M. Luckiesh	232
Problems of Wage Payment. By H. N. Stronck	236
The Vulcanization of Rubber. By Andrew H. King	243
A New Source of Potash	248
The Effect of Addition Agents in Flotation—III. By M. H. Thorberry and H. T. Mann	249
Ceramics and the War. By Edward W. Washburn	253
Sulphuric Acid Production in 1917	255
The Trumble Oil-Refining Process	256
Plate-and-Frame Filtration. By D. R. Sperry	258
Synopsis of Recent Metallurgical and Chemical Literature	260
Recent Metallurgical and Chemical Patents	262
The Parker Rust-Proofing Process	264
American Clay for Graphite Crucibles	265
Personal	265
Obituary	266
Book Reviews	266
Current Market Reports—Iron and Steel Market, Chemical Market, Non-Ferrous Metal Market and Chemical Price List	267
Industrial, Financial, Construction and Operation and Manufacturers' News and Notes	271

Discipline

OCCASIONALLY an American has been both bold and frank enough to remind us that as a nation we have a distaste for discipline and a lack of respect for authority; but our complacency has shed the criticism as effectually as a duck's back turns water. Having given no heed to our own critics, perhaps we will the more gracefully accept the same sentiment when expressed by a friendly but earnest ally.

It would have had a salutary effect if every intelligent man in this nation could have been sobered by the direct challenge of Capt. Hodder-Williams, of the British Expeditionary Force, when he told the mining engineers assembled in New York that America's greatest need was discipline and that without it we could not hope to win the war. He spoke as one who has been tried by fire and who knows what it is to lead troops in whose discipline there could be no question. He stated the problem tersely when he explained that discipline must extend beyond the army throughout the whole people, and he illustrated this need clearly when he said that the allied armies would take care of the German military forces, but that the American people must match the German people in discipline—discipline in saving, discipline in co-operation, discipline in sacrifice, discipline in service and discipline in loyalty to the government. The German people are disciplined, and that quality has told in their favor. We too must achieve that end, self-taught because no stern, harsh and rigorous government has trained us. We may scorn the outward and visible signs of discipline, but we must learn to value the inward grace. The great task set for the American people by our ally is self-discipline.

A Little Homily on the Tariff

AT A MEETING of the editors of technical journals held in Washington some time ago, Chairman Tausig of the United States Tariff Commission impressed urgently upon those present the fact that the commission was the creature of Congress and that its function was to present facts. "Our business," said he, "is to gather information, and submit reports to Congress to enable the Congressional Committee and the legislative bodies to deal knowingly with the problems that are presented to them." He said many other things, some of which were confidential and others for publication, and his exposition was at once able and thoughtful. But let us content ourselves with the foregoing as a text, and consider some features that relate to it, most of which he did not mention.

When a tariff bill reaches Congress it has a hard row to hoe because the agents of special interests are always present, and they move to amend in such a way as to benefit the constituent or friend of the amending

representative. It is likely that the information available from the commission will aid in preventing jokers and trades between Congressmen because the proper co-ordination of facts leads to the truth, and when the truth is made intelligible in this manner tinkering becomes difficult.

We know very well that Congress can, by a single enactment, ruin a large part of American industry. There is no reason to think that it will, unless bolshevism becomes epidemic in this country, and in that event it will not make much difference what the laws are. But even with our faces turned toward the morning and with hope alive within us, there is one thing of which we may be sure; and Congress is bound to be very sensitive about it because the people at large are growing increasingly so. It will not do any more to "put something over" upon Congress. The general welfare must be considered and not that of special interests. If a heavy duty on some article made here under difficulties is likely to cripple industry at large, it becomes the obligation of the industries that use the product to look out for this link in their chain of needed materials to the end that they can get it made here at a reasonable price. If Congress is asked to make it duty-free, very likely it will—and then it will proceed to make other things duty-free. Congress does not always discriminate with nice precision. If a high duty is imposed, then industry at large will want higher duties to meet the increased cost, and that is the road of danger that leads along the line of soap boxes from which orators call for unconditional free trade and free love and free property.

The Tariff Commission can give no aid in this connection.

Another feature of leading importance that calls for an entirely new angle of vision from manufacturers is the relation of tariff duties to wages. The old line of argument was to generalize and to claim maximum duties for the benefit of the American workingman, no matter whether he got the benefit in whole or in part or not at all. The Commission, on the other hand, will look for the specific relations of labor to product; and generalizations fall down in the face of co-ordinated facts unless they support them. It will examine the relation of import duties to wages in detail; it will exhibit facts instead of claims. Heretofore the welfare of labor has occasionally been used as an argument to cover paucity of research on the part of American manufacturers. That will not do any more. American products must take their places beside those of foreign make and stand or fall by the comparison. Shiftless factory practice and wasteful processes will display themselves without mercy. Scientific research in foreign laboratories must be met by research in American laboratories and these results must be applied to factory practice. This war is causing the whole world to grow very much in earnest. It will not do to regard the tariff, as it frequently has been regarded in the past, as a substitute for research. Progressive industry cannot endure such a wrench in its intermediates any more.

In short, with the world sick with grief over death, and weary with the fever of anger and war, it will not do even to think that prosperity may be achieved by legislation alone. Everybody must work, not only hard but with intelligence. There will be no protection for the incompetent.

The Chemical Alliance

IT was necessary to disband the advisory committees of the Council of National Defense because of a law which was passed making it a misdemeanor for anyone acting in an official advisory capacity to the government to counsel the purchase of wares produced by an organization in which he is interested. Inasmuch as the committees comprised the leading manufacturers of the country no other course was open. At the same time a great deal of useful work had been started, and it was suggested that to meet the needs of the government each industry proceed to organize itself. The Chemical Alliance was proposed for the chemical industry as a whole and this received the hearty approval and encouragement of the War Industries Board, more particularly Mr. Baruch, who, as Commissioner of Raw Materials, has to do with the purchase of chemicals.

There was a considerable number of organizations already established, and without taking the place of these—none of which covered so wide a field—the Alliance sought to profit by their facilities as much as possible. Two noteworthy organizations were those of the fertilizer manufacturers which has active headquarters in Washington, of which Mr. Horace Bowker is the head, and the Manufacturing Chemists' Association, of which Mr. Henry Howard is chairman of the executive committee. At the first annual meeting which we reported in our last number, these gentlemen were elected respectively president and vice-president of the Alliance, and a board of directors consisting of men who occupy the first rank in chemical industry was chosen.

The Alliance has a great deal to do, as we shall observe in the enumeration of some of its problems.

There is co-operation with the government through the Army, Navy and War Industries Board in the continuation of statistical work. An important feature in this connection is the revision of the forms sent to manufacturers for the purpose of gathering information. The forms as prepared have overshot their mark in calling for such elaborate detail that large and important corporations cannot furnish it within reasonable time or without serious disturbances to their procedure.

Co-operation with other boards in the matter of foreign pyrites is needed so that the proper distribution of the material when it is received to the points where it is most urgently required at the time, may be provided for.

The question of supply against the increased programs of the War Department is important. If it is resolved to increase the production of certain munitions, the availability of the necessary materials is immediately studied and the most expeditious and economical program is worked out and presented. In this connection the opinions of the leading men in the trade are of distinct value.

The question has occasionally to be determined as to certain materials, whether they are made here or not; if they are made, who makes them; and if not, who is equipped to make them.

Statements from all the members of the Alliance as to what they can produce constitute information that is far more enlightening than statements of two

or three makers in response to inquiries sent out in the usual manner. This detailed information as to the capacity of an industry, right up to the minute, with the chances of profiteering reduced to the minimum, is something that never has been available before in this country. It also solves problems relating to coal and transportation, showing how the government may supply its needs with the least freight movement. Shipments, for instance, of the same material from one producer in New England to the Middle West and from another producer in the Middle West to New England may thus be avoided in government work at a great saving of time and haulage.

The very delicate question in the case of shortage of supplies as to which industries may be curtailed with least injury to the general welfare is one to be carefully studied and the results contributed to the government authorities if they are asked for.

As chairman of the former Advisory Committee, Dr. Nichols introduced a very profitable method of procedure whereby, at each meeting, the chairman of each section told what had happened within his section since they had last foregathered. This enabled the committee to make studies of products that were bound to be called for, but for which the authorities had not yet formulated their requests. The method has been continued.

In other words, here is a great organization, built up of the leading men in chemical industry, the purpose of which is to help win the war. All manufacturers of chemicals are urgently invited to join it. It is neither a kicking committee nor a profiteering layout. It is the strongest and ablest manufacturing board ever brought together in the United States in chemical industry.

Manufacturers should swallow their fears that competitors may find out something about them and join. We have just one arch-competitor now and that is the German Army and Navy, coupled with the German High Council of Deceit. The only way to beat it is to pull together.

Competition in Steel After the War

LONDON *Engineering* has a very interesting editorial, printed in part elsewhere, as to the prospect of iron and steel competition between Britain and the United States after the war. There is a decidedly able review of what has occurred in the past 30 years, Britain losing her supremacy, Germany coming to the front and the United States failing to make good the promise of 15 or 20 years ago as to its place in the international market, but the editor is less precise when referring to prospects after the war. He inclines to the general belief that costs will be high in the United States, and as to Britain, he is rather oracular—Delphic oracular—in saying that it “rests with themselves,” that their statesmen must protect their markets and encourage enterprise, that manufacturers and shippers must organize better and the workmen must adopt a more enlightened attitude.

Without wishing to steal any one's ideas, we venture to observe that the same remarks made about the United States would not be altogether lacking in point. If our government will co-operate with business—and

the ice has certainly not merely been broken but melted in the past twelvemonth—not if our manufacturers and shippers will organize better, but if the government will let them, and if our workmen take a reasonable view as to working hard and a decent number of hours, we can do a great deal.

In detail, however, we think somewhat more specific speculations can be indulged in as to American industry immediately after the war, say for a couple of years, than are hazarded by our London contemporary. In the first place, there will be a shortage of shipping. “Ships will win the war,” and it seems obvious, therefore, that the war will be won long before there are enough ships for the regular commerce of the world. Demobilization will employ a great many ships, moreover. Export trade will be confined largely to the more valuable and more highly finished products, including machinery, for instance, rather than the tonnage products of the iron and steel industry.

Apart from ocean shipping conditions, the position of the United States in relation to the rest of the world will be altogether altered. Before the war it was necessary to have a large favorable balance in merchandise trade in order to meet various requirements, including payments on American securities held abroad. We quote from the annual report of the Comptroller of the Currency, made Feb. 1, to the effect that since the war started the favorable merchandise trade balance has resulted in our importing about a billion dollars of gold, in practically paying off five billions owned abroad in the shape of American securities, and in our loaning foreign countries two billions, apart from the large advances made by the government itself to our Allies. In such circumstances, merely to “break even” as we did in the past would involve our importing much more merchandise than we exported, instead of the reverse as was formerly the case.

The circumstances will be such as to require the keenest effort to maintain a large export trade. Prices will be high in the United States, the essence of the situation being that the gold dollar will be cheap. That will tend to make it difficult for us to export, but easy for us to conduct a large domestic trade. A very large consumption of iron and steel will naturally be involved. It is natural that our friends abroad should wonder what we are going to do with our surplus when we increase productive capacity as we have done in the past two years. We have pondered the same idea ourselves. In previous cases of expansion, however, we found employment for the surplus at home after all. Our foreign trade did not grow in the past in keeping with our expanding production.

In the matter of international competition we have, perhaps, even greater obstacles to overcome than our London contemporary considers. The period was very brief when we made particularly cheap steel. It was when we were using Mesabi ore from just beneath the surface, with a ridiculously low cost of mining, and ore that was very much richer than what we are forced now to use. More ore must be transported per ton of pig iron, and much more limestone and coke used. Measured in absolute units of effort expended and equipment used, not in the fluctuating standard of the gold dollar, our cost of producing steel is much higher than when we made our reputation in the closing years of the nineteenth century.

Factors in World Trade Competition

A CRITICAL analysis of world trade in iron and steel recently appeared in the editorial columns of *Engineering* (London), from which we make the following excerpt:

The future race for supremacy in the iron, steel and engineering export trade, the world's most important group of manufacturing industries, will probably be mainly between the United States and the United Kingdom. In the last thirty years before the war the Germans increased their output of iron, steel and engineering products, measured in terms of pig-iron, from 3,000,000 tons a year to 19,000,000 tons. In the same period we only increased our output from 8,000,000 tons a year to 9,000,000 tons. In the last fifteen years before the war the protected, organized and subsidized German trade increased its exports of iron and steel goods from less than 1,000,000 tons a year to 6,000,000 tons, while we in those fifteen years only increased our exports of iron and steel from 3,500,000 tons a year to 5,000,000 tons. We lost the lead because we failed to protect our industries, failed to organize, and failed to work hard. Our statesmen would not give productive industry the slightest protection or encouragement, or even the commonest of fair play. Our manufacturers and shippers would not drop their conservatism, or sink their individualism and co-operate for the common good. Our workmen lost 100,000,000 separate working days by strikes in ten years; they opposed machinery; they limited apprentices, and deliberately "slow-timed" their work. After the war we have to protect and organize and develop our industries on common-sense lines, work diligently, enter into preferential trading arrangements with our Colonies and Allies, and avoid German goods. We have to wake up and do these things or perish. We can easily beat Germany if we try * * * but there remains the question of American competition.

It is, therefore, useful to examine broadly the comparative resources of the United States and the United Kingdom. Roughly, there was a world's export trade in iron and steel aggregating 18,000,000 tons a year before the war, valued at more than £200,000,000, besides machinery valued at another £20,000,000. In round figures, Germany was exporting 6,000,000 tons of iron and steel annually; Britain, 5,000,000 tons, and America, 1,500,000 tons. After the war it is more than probable that this trade will be greater in volume and much greater in value than before the war. It is highly likely that Germany's share will be much smaller than it was before the war, which means that more will stand to be divided between the United Kingdom and the United States. By the way, these three countries—America, Germany and Britain—produce somewhere about 85 per cent of the world's total of iron, steel and engineering products. Until the outbreak of war the United States, although possessing a productive capacity equal to that of Britain and Germany put together, never had more than a meager share of the world's export business, as indicated by the above figures. But the opinion is strongly held in some quarters that America will henceforth undertake an export trade in some way commensurate with her capacity of production. What are the prospects? Briefly, it may be said that in abundance of natural resources and in amplitude of

productive capacity, the United States is in a position to undertake something like the lion's share of the steel export business, easily beating both us and the Germans; but that in geographical compactness, in the powers of cheap production, and in shipping facilities Britain is much better situated. The United States has the most coal and iron ore. The United Kingdom has the best assemblage, manufacturing and shipment accommodation.

In order to weigh up the position and prospects it is necessary to take a glance backwards. Between fifteen and twenty years ago, while the resources of America—and of most other countries, for that matter—were egregiously exaggerated, not only by American, but by our own public speakers and writers, our own resources were just as absurdly underestimated. It was boldly declared that America could produce the cheapest steel; that we were rapidly becoming industrially bankrupt through the exhaustion of our coal and iron supplies, and the United States would soon flood the world's markets with manufactured goods at prices we could not touch. But the threatened "American Invasion" did not materialize. The Americans vastly increased their capacity. Between 1900 and the outbreak of war they increased their steel works capacity, in terms of pig-iron or steel ingots, from 15,000,000 tons a year to nearly 40,000,000 tons. But they exported very little more in 1914 than they did in 1900. The bulk of the world's export business had gone to the Germans. Relatively, the Americans declined from a promising second to a bad third place in the race, whilst the Germans went rapidly ahead from third to first place, and we fell from a long lead to the second position. If we had paid less attention to the threats of American competition, to the exaggerations of the resources of other countries, and to the scares about our own supplies of raw materials, and had kept our industries advancing concurrently with the world's growing demand for manufactures, we should never have been beaten by Germany, nor need we have feared the competition of any other country. Although our combined productive capacity was less than that of the United States, we exported something like 10,000,000 tons of iron and steel a year, against America's 1,000,000 tons to 1,500,000 tons.

Now, in view of the coming new international competition, it is of prime importance to inquire why the United States, with such a huge capacity of production, has taken such a meager share of exportation business. The reason is that our American rivals have been unable to produce and ship steel goods at competitive prices, notwithstanding all their great natural resources. And this brings us to the central and supreme fact in the issues involved. With their iron ore deposited a thousand miles from their coal mines, and their iron and steel works mostly between 400 miles and 500 miles from the seaboard, and with wages and salaries exceedingly high, the Americans have not been able to sell at a profit, or at competitive prices, outside their own protected home market. Just as the Americans rapidly increased their works capacity, so the costs of their manufacture advanced.

From time to time we hear a great deal about the superiority of American labor, but the figures given in this connection are misleading. They make no due allowance for the vastly greater expenditure on machin-

ery and automatic appliances in America, compared with Britain. If half what we have been told so often about American efficiency and economy had been true, British goods would have been swept clean off the world's markets long ago. The simple fact is that the Americans cannot produce and ship general manufactured goods so cheaply as we can. Some high authorities hold the view that one economic effect of the war will be so to enhance our costs as to enable the United States to produce and ship at least as cheaply as ourselves and the Germans. Many American enterprises and associations are laying their plans in this belief. Much, if not everything, will depend upon ourselves. If we stick too closely to old methods and policies we may be beaten both by American and Germans, not to mention other nations. If our statesmen will not protect our markets and encourage enterprise more than they did before the war, if our manufacturers and shippers will not organize better, and if our workmen will not adopt a more enlightened attitude toward machinery and large-scale production, we shall certainly be beaten. But with anything like intelligent co-operation between the state and industry, and between capital and labor, we should again obtain and retain supremacy in the world's export trade. While the Americans should enjoy highly prosperous trade in their own rich, protected home market, and obtain a considerable share of international business hitherto done by the Germans, we should easily take a long lead in the trade in manufactured exports, and also in shipping.

The Administration Water-Power Bill

IT WILL be interesting to relate some of the facilities that are available for water-power development, the reasons why they are not developed, and to point out what is necessary to bring this about.

The occasional River and Harbor Bills that have been brought before Congress have been justly criticized. They provide in part for prospective river transportation with but rare provision for the use of the power available at or near the dams. Vast sums have been appropriated and some work has been done here and there in the hope that tug boats and wooden or steel barges would come along and carry things—but in the main they haven't come along.

The waterways and power sites of the country are under three departments of government. The navigable rivers, including those that are prospectively navigable—that is, extensions that may be made by dredging, digging canals and the construction of locks and dams—are under the jurisdiction of the Secretary of War. This jurisdiction is changeable and may be extended or withdrawn according to his judgment. The waterways which extend through public lands are under the jurisdiction of the Secretary of the Interior. Those in the national forests are in the keeping of the Secretary of Agriculture. This divided authority has discouraged progress.

To get at the matter more concretely, consider the situation in regard to some thirty-two rivers now held to be either navigable or prospectively so, which are under the jurisdiction of the Secretary of War. The list does not include the Hudson or any stream which has reached its possible development. On these thirty-

two rivers alone there is 10,183,950 hp. available. The development of this would add the possibility of 4324 miles of navigable waterways, in most cases where they are greatly needed. In providing for water-power developments by private capital it is right and proper that the interest of navigation be made a part of the contract. The cost to the government for building the necessary canals is then but a fraction of what it would be under the old River and Harbor Bill method, because dams and slack water are already provided by the water-power enterprises.

Another advantage to transportation that would accrue is that reinforced concrete barges may be built very cheaply within a short time and the means of propulsion of such barges is often available at the waterpower sites. When we burn coal to make steam to push a boat ahead a vast amount of energy is lost in pushing the water back. With proper electric towing facilities this energy is not lost, and the question of transportation of heavy staples in the open season by rail drops out of consideration except where the traffic is too light to bear the cost of installation.

Abundant and cheap water transportation thus becomes available as soon as our water powers are developed. Log-rolling and inertia are likely to disappear as soon as a proposal of this sort becomes concrete and the public knows what is to be expected of it. Then the completion of the whole will be demanded instead of the wasteful expenditure of money for the major purpose of bringing it into circulation in local districts.

Now of these water-power resources of 10,183,950 hp.—and they are nearly all attractive engineering possibilities—there are already developed, so far as we are able to gather, 611,141 hp. Over 9,500,000 available horsepower on these thirty-two rivers is undeveloped. The mileage of canals already built is insignificant.

Why is this? First, let us remember that it takes far more effort to build a great machine and to start it than it does to stop it and break it down. A monkey wrench or some emery powder or any one of a great many insignificant things can stop a machine. It is the same with the machinery of capital in great undertakings. Capital invested in water-power propositions is a long time investment. It does not turn itself over every year or even oftener than once in eight years. It is necessary that the fee or title to such property be good because the sums required are very large and the investor cannot get in and get out like a trader on the Stock Exchange. Titles to water-power developments have always been rather complex in this country. The United States Government is sovereign, and licenses can be recalled, although it was held that they would not be. With this in view, from ten to fifteen years ago the prospects for the construction of water-power installations were very favorable, and many projects were under way. But on February 27, 1909, the Hon. James R. Garfield, 2nd, then Secretary of the Interior, withdrew the permits to twenty-five water-power grants on the ground that it was desirable to bring all licenses under new and more restricted rules. The effect upon further developments was disastrous, not because of new restrictions, but because, after all, the government might and in fact did withdraw licenses after they had been granted. That is

what threw the scare into capital. We are not condemning Mr. Garfield; he did what he thought was right, without doubt; but he certainly gave a jolt to the growth of water-power developments.

Another cause may be found in the fashion and style of the thought of the day. It has been and still is held to be contrary to public policy to allow any one or any corporation which enjoys a special permit or license from the government to grow very rich. We shall make no comment upon this fashion; it is in vogue and we should be only wasting our substance in opposing it, while it does not need our aid in its growth.

Our present laws controlling the development of navigable streams give tenure for a maximum of 50 years, but at the end of that time the United States Government may not only take over the property without compensation, but even charge the licensee with the cost of dynamite to blow up his dam. The result of all these causes is hardly less than an embargo on the industry.

In the last Congress the Shields Bill in the Senate provided a plain contract for 50 years on "navigable" streams (the term being used in the sense of the War Department as indicating also those prospectively navigable). At the end of such time the government was to have the option to take over the works at a fair value, or, if this was not done, the original grantee was to remain in possession for an indeterminate time subject to the pleasure of the government. It provided for the regulation of rates of service and maintained that navigation was of paramount interest. It provided also among other things that if Congress should cancel the grant the owner should be indemnified for his investment at a fair value.

This met with violent opposition from Mr. Gifford Pinchot and his followers; one of the principal objections being that the grants would be, in effect, perpetual investments, as the inertia of government would be too great to provide for taking over the property after 50 years. It was also held that the government should not pay for appreciation in value.

This year an administration bill has been introduced which is full of merit. It provides a commission of the Secretaries of War, Interior and Agriculture, who shall be in a position to give a license for 50 years. At least two years before the expiration of the term the licensee may apply for a new grant. This the government may allow or it may take over the property at a fair value not to exceed the actual cost, or a new license may be granted to a third party who shall pay to the original licensee a fair value not to exceed actual cost or, again, a new license may be granted to the original licensee under the terms of the then existing laws. The Commission may impose a rental for such sum as it may determine, but at a minimum of 10 cents per horsepower-year.

The measure as a whole, which includes supervision of rates and service, is an excellent one with the exception of certain features which may be eliminated; or they may have to be included by way of compromise. The 10 cents per horsepower-year is a light tax, but it has the effect of discouraging the development of reserve power before it can be sold. If the incidence of this or even a higher tax were to apply as soon as power is sold rather than as soon as it is developed, it would appear to be better.

The main thing is to get the bill passed. It provides a 50-year contract, irrevocable except for just causes, and with some small changes in minor particulars will make of water-power developments a fair banking proposition. Control of rates and service is now an accepted factor in public service corporations and the hazard of confiscation by burdensome impositions is no greater than with others. A secure title is absolutely necessary and this seems assured for 50 years.

It would seem reasonable to hold, with rates and service under supervision and with publicity in financing and accounting provided for, that security of possession and the avoidance of actual loss of investment under recapture at the end of the license, would provide for the lowest cost of organization and consequently the lowest cost of service, and that low cost of service would be reflected in rates. United States bonds sell because they are safe; if there were a question of discount at redemption, the discount would show in the price. The injection of hazards into a security puts it over into the speculative class, depreciates its value at the start, and makes it a rich man's opportunity. If the security is good the bonds are easy to sell, bonuses do not have to be given, the poor man can invest his savings in it and nobody is likely to get surprisingly rich out of it. If the site is good or the power is needed, the investors after all may make good money out of it, and that is, according to a certain prevalent school of political philosophy, a thing to be avoided at any cost whatever.

The passage of this bill, or one with equally fair provisions, is urgently needed. We urge it with all our might in the name of electrochemistry, which bids fair to leave this country if additional water power is not soon at hand. We urge it for American farmers who need cheap water transportation, as do the manufacturers and merchants of the interior. And we urge it for the general welfare.

New Western Office of Metallurgical and Chemical Engineering

FOR the past eight years METALLURGICAL AND CHEMICAL ENGINEERING has maintained a Western editorial office at Denver to enable it to reflect accurately the progress of Western metallurgy. Recently that office has been established at 1101 Newhouse Bldg., Salt Lake City, Utah, in charge of Mr. Ernest E. Thum, a metallurgical engineer trained and experienced in Western practice. Centrally situated in the region west of the Rocky Mountains, Salt Lake City has gained increasing importance as a metallurgical center, and the establishment of our office there will enable us to keep in close touch with developments. Our readers are invited to call upon Mr. Thum for any service he can render.

Coming Meetings and Events

Dyestuff Association of America, Rumford Hall, Chemists' Club, New York, March 6.

American Electrochemical Society, Spring meeting, Southern trip, week of April 28.

American Society of Mechanical Engineers, Worcester, Mass., June 4-7.

American Society for Testing Materials, Atlantic City, June 25-28.

New York Meeting of the American Institute of Mining Engineers

Notable War-Time Gathering of Mining Engineers in Annual Session. Report of Business and Technical Sessions. Sidney J. Jennings Elected President. Fall Meeting to Be Held in Colorado

THE 116th meeting of the American Institute of Mining Engineers, held in New York, Feb. 18 to 21, was a notable gathering of engineers in war time. In many respects the programs had a war interest and value, and the spirit of national service was much in evidence. All things considered, there was a generous attendance from such distant states as Montana, Colorado and Missouri, particularly the last where the preceding meeting was held.

ANNUAL BUSINESS MEETING

The tellers appointed to canvass the ballots for officers for the year, beginning March 1, declared the following results: President, SIDNEY J. JENNINGS; Vice-Presidents, HENRY S. DRINKER and ROBERT M. RAYMOND; Directors, F. G. COTTRELL, HENNEN JENNINGS, GEORGE C. STONE, SAMUEL A. TAYLOR and ARTHUR THACHER.

The amendment relating to qualifications for membership in the Institute was carried by a vote of 1123 to 59. Under the terms of the amendment, which has been published in the Institute *Bulletin*, future members will have to meet certain requirements and will be classed accordingly.

Plans were made to hold the fall meeting of the Institute in Colorado Springs, Colo., and vicinity.

ENTERTAINMENT OF MEMBERS AND LADIES

A visit to the new subway workings gave an opportunity to see the methods of excavation and timbering employed in the hard rock of Manhattan Island and the glacial drift of Long Island. In the former case rock excavation was carried on for a new subway beneath one in which a train was passing on an average of every 30 seconds.

Mr. MARK R. LAMB exhibited motion picture views of Bolivian tin mines.

At the war smoker, which was presided over by Dr. A. R. LEDOUX, there were a number of interesting and inspiring addresses. Capt. R. HODDER-WILLIAMS of the British Expeditionary Force reminded the American people of the necessity of discipline, not only in our army but throughout the mass of the people. He was followed by a representative of France who expressed the gratitude of his people for the assistance now being rendered by the United States.

The work of the Fuel Administration was explained by S. A. TAYLOR and M. L. REQUA, the latter having recently been placed in charge of the oil division. Mr. W. L. HONNOLD spoke for the Belgian Relief Commission and explained that during the last six months it had been possible to supply only 60 per cent of the requirements of Belgium and northern France. A total of over \$400,000,000 has been disbursed by the commission. The War Minerals Committee was represented by its Chairman, WILLIAM Y. WESTERVELT, who asked support for the bill through which Congress will be asked to grant powers to a mineral administrator.

On Wednesday evening the reception of the incoming and retiring presidents, and the "Hoover" dinner were held at the Hotel Biltmore. President Moore acted as toastmaster at the dinner and called upon Captain Dulieux of the French High Commission, W. I. Hotchkiss of the War Minerals Committee, Bainbridge Colby of the United States Shipping Board; W. S. Miller, geologist of Canada, and Sidney J. Jennings.

The Ladies' Auxiliary of the Institute took charge of entertainment of visiting ladies. On Monday visits were made to the art galleries of Henry C. Fricke and W. A. Clark. A motion picture exhibit of devastated regions in northern France was given on Tuesday, followed by a visit to the Metropolitan Museum of Art. In the evening President-elect and Mrs. Sidney J. Jennings held a reception at their residence. On Wednesday morning Dr. ALEX-

ANDER CAIRNS, representing the Food Administration, gave an illustrated talk on "Feeding the Multitude," and was followed by a speaker for the Commission for Relief in Belgium. Wednesday afternoon there was a theater party for the ladies to see a performance of "Chu Chin Chow."

TRIP TO PRINCETON

Thursday was devoted to an all-day trip to Princeton University. Luncheon was served in Proctor Hall of the Graduate College, after which President Hibben of Princeton addressed the audience. He spoke of the fundamental, constructive nature of the work of engineers, not only in war but also in peace. President Moore responded for the institute.

The party was then conducted through the Ground



SIDNEY J. JENNINGS

President American Institute of Mining Engineers

Aviation School and the scientific laboratories of the university and entrained for New York.

SESSION ON NON-FERROUS METALLURGY

This session was held on Monday morning with G. H. CLEVINGER in the chair.

The Disadvantages of Chrome Brick in Copper Reverberatory Furnaces, by F. R. PYNE. This paper has already been published in our issue for Jan. 1, 1918, p. 20. The author had found hydraulically pressed magnesite brick preferable to chrome. In discussing the paper, Prof. H. O. HOFMAN said:

"The paper by Mr. Pyne gives clear evidence of the difficulties the metallurgist is likely to encounter when he tries to recover in the blast furnace the metal from old chromite lining used as a refractory material in the copper reverberatory furnace. It appears that chromite cannot be fluxed at temperatures which usually prevail in copper blast furnaces. This calls to mind the freezing-point curve drawn by M. Simonis of mixtures of chromite and kaolinite. (See *Stahl und Eisen*, 1908, Vol. 28, p. 335.) The chromite used in the experiments contained 52.9 per cent Cr_2O_3 , 22.6 FeO, 4.8 Al_2O_3 , 9.6 SiO_2 , 10.1 MgO; the kaolinite was clay from Zettlitz with 98.5 per cent clay-substance. The eutectic mixture with 35 per cent kaolinite and 65 per cent chromite freezes at Seger cone No. 15 (1435 deg. C.), while kaolinite fuses at cone No. 35 (1770 deg. C.) and chromite at cone No. 42 (2000 deg. C.). The curve indicates that the difficulty in the blast furnace can be overcome by having at the smelting zone a temperature much higher than is usual in copper smelting; a charge composition similar to that prevailing at the Mansfeld copper smelter—which gives with 23 per cent coke a slag of the composition SiO_2 49.09, $(\text{FeMg})\text{O}$ 5.58, $(\text{CaMg})\text{O}$ 16.02, Al_2O_3 16.02—might flux and fuse chromite."

Mr. Pyne said that ferrochromium could be made from the chromite and that his company had considered installing an electric furnace for this purpose, but the war had required their attention on other things. Mr. Clevenger said it had been his experience that chrome brick formed a poor furnace lining for electric furnaces operating at high temperature. Mr. Forest Rutherford said he agreed with Mr. Pyne on the metal absorption by chrome brick and on the difficulty of fluxing chrome bats. On the other hand, he said he had found magnesite unsatisfactory for reverberatory furnaces except in the roof. He had used at the Copper Queen Works, Douglas, Ariz., a lining consisting of a layer of magnesite, a layer of chrome and a layer of silica; the latter forming the inner furnace surface. Mr. Stoughton said it was patriotic not to use any more chrome brick than necessary on account of the shortage and the fact that there were certain places where it must be used.

Fine-grinding and Porous-Briquetting of the Zinc Charge, by WOOLSEY MCA. JOHNSON. The author made some experiments with the idea of reducing the coal and coke used by charging finely-ground porous material. It was reasoned that such a charge could also be much more easily reduced and would have greater heat conductivity. From his experiments he figured a reduction in cost of \$5.67, by means of increased charging, resulting from fine-grinding, ventilating and briquetting, assuming a cost of \$17 per ton of ore. The reduction in "charge" coal cuts the cost of coal from \$2 to \$1.20. There would be a certain reduction in furnace

labor and also in retort consumption because the charge gives a residue that blows out clean. The recovery will be increased because of low residues and decreased retort-consumption; perhaps this saving will amount to \$3. The credits thus total \$10.97 while the debit is \$1.50; or a total net saving of \$9.47 is possible. The briquetting needs a special binder. In the discussion Mr. O. C. Ralston said that the zinc smelters complain of the large amount of flue dust from roasting and that some such method as described by Mr. Johnson would be the solution of the problem. Mr. Hall of the New Jersey Zinc Company asked what binder was used and what per cent. Mr. Johnson said 10 to 12 per cent of sludge acid from oil refining gave good results.

High-Temperature Resistance Furnaces with Ductile Tungsten or Molybdenum Resistors, by W. E. RUDER. This paper described various types of furnaces developed by the Research Laboratory of the General Electric Company to meet the general needs of laboratory work. Since the discovery, by this laboratory, of methods for producing tungsten and molybdenum in ductile form, their use as resistance elements in the Research Laboratory of the General Electric Company has grown to such an extent that they are now almost indispensable. These furnaces are used here for alloy research, annealing, heat-treating, and practically all of the thermal processes requiring temperatures above 900 deg. C. In discussing the paper Mr. Spilsbury asked whether the furnaces were for laboratory purposes only. Mr. Ruder replied that they were, and had been developed originally for heat-treating tungsten. Mr. Hall asked whether the author had used reducing gases in such furnaces. Mr. Ruder said he found trouble getting a tube which would not leak gas at a high temperature.

Zinc Refining, by LELAND E. WEMPLE of the American Zinc, Lead and Smelting Company, St. Louis, Mo. Mr. Wemple first discussed in a general way the impurities in spelter and methods of reducing same, and the need for high-grade spelter since the war began. He then took up redistillation methods which are in use and proposed, and also discussed refining by remelting and the grade of the refined zinc. In the discussion Mr. Spilsbury asked what the total loss was in redistillation, including lead, blue powder and the final remelting. Mr. Wemple said that approximately 5 per cent was lost on the first operation. This is a zinc loss. The lead should not be considered a loss, as it is finally recovered. The by-products run about 15 per cent, consisting of blue powder, skimmings, etc. About 3 per cent of this is scrap and the balance blue powder. The net loss is about 6 to 7 per cent of the zinc content of the charge. Mr. W. McA. Johnson asked what percentage of lead was carried over mechanically and what percentage by vapor pressure. The author had no data but said it was possible to produce zinc with only 0.03 per cent lead by running near the boiling point of zinc, but as the temperature goes higher the lead increases. If not careful 0.25 to 0.30 per cent lead can be produced. The essential thing to keep the lead down to low limits is heat control.

The other two papers presented at this session were *Bone-Ash Cupels*, by F. P. DEWEY, of the Bureau of the Mint, and *An Automatic Filter at Depue, Ill.*, by G. S. BROOKS and L. G. DUNCAN. A synopsis of Mr. Dewey's paper appears in this issue, page 260.

SESSION ON MINING AND MILLING

Hints on Bucket-Elevator Operation, by A. M. NICHOLAS. This paper gave some practical hints from the author's experience. The settling of heavy pulp in the buckets, with consequent failure to discharge the load, was overcome by agitating the belt about midway of its span. The cutting of elevator belts by sharp rock was overcome by attaching a wooden shield below each bucket to prevent fine particles of rock from falling between the belt and the bucket when the latter passed over the head pulley. A balata belt thus equipped has been in use for two years and has hoisted about 50,000 tons of rock. The slipping of narrow high-speed belts can be prevented by using a belt made of small blocks of leather overlapping at the ends and pinned through with metal pins.

Recent Tests of Ball-Mill Crushing, by CHARLES T. VAN WINKLE. This paper was published in extended abstract in our issue for Jan. 15, page 207. It concerns tests of Hardinge & Marcy Mills. In discussing this paper Mr. PARKE CHANNING stated that the problem presented to Hardinge and Marcy was to install crushing capacity for 1000 tons per day, each using two mills. The Miami staff had considered Mr. Hardinge unwise to attempt the test with less than three mills, and the unsatisfactory results obtained by him are attributed to his attempt to do the work with two mills. The original Miami mill had a set of rolls and two Hardinge mills for each section, but later they put three Hardinge mills in each section and the results were satisfactory.

In further discussion Mr. B. BRITTON GOTTSBERGER submitted a concise statement of the work now done at Miami in a completed section, using three Hardinge mills for fine grinding.

The ore hoisted through the main shaft is dumped into a 1000-ton bin located at the head of the crusher plant. The plant consists of No. 7½ gyratory crushers followed by two sets of rolls 55 in. by 20 in. and 42 in. by 16 in., respectively, operating in closed circuit with trommels fitted with screens having ¾ in. by 1½ in. slotted holes. Practically all of the product produced will pass a ¾-in. round hole, as shown by the average screen analysis for the month of January given below:

TABLE I.—SCREEN ANALYSIS OF FEED TO BALL-MILLS

	Per Cent.	Cum. Per Cent.
On ¾-in. round hole	1.1	1.1
On ½-in. round hole	13.8	14.9
On ¾-in. round hole	13.7	28.6
On ½-in. round hole	12.2	40.8
On 1/16-in. round hole	7.4	48.2
On ¼-in. round hole	9.3	57.5
On 10-mesh	8.3	65.8
On 14-mesh	4.4	70.2
On 20-mesh	3.3	73.5
On 28-mesh	4.0	77.5
On 35-mesh	2.4	79.9
On 48-mesh	2.7	82.6
On 65-mesh	2.0	84.6
On 100-mesh	1.5	86.1
On 150-mesh	1.9	88.0
On 200-mesh	1.3	89.3
Through 200-mesh	10.7	
	100	

The product of the crusher plant is carried by belt conveyors to the mill bins located back of each section of the plant with a total capacity of about 10,000 tons. From this point reduction of the ore is carried out entirely in Hardinge ball-mills, three of these machines being installed in each section to handle approximately 1000 tons per day of crusher plant product, which is ground to a point where practically nothing remains upon a 48-mesh screen. The mills used are built of cast iron and are 8 ft. in diameter by 36 in. length of barrel, driven direct by electric motors through Wuest gears. Each mill is equipped with a 150-hp. motor and runs at 20.6 r.p.m.

The grinding is at present done in two stages. The entire section tonnage is first subjected to single-pass crushing through one mill, the product passing to a 4-ft. 6-in. Dorr classifier. The overflow of the classifier is finished product. The sand product of the classifier, representing the oversize of the first mill, is divided equally between two mills of the same size, each operating in closed circuit with a 6-ft. Dorr classifier. The overflow of these classifiers is finished product, the sands being returned to the mills for regrinding. The product produced by this system of grinding is shown by the following average screen analysis of the tailing of Section 6 of the plant for the month of January, 1918:

TABLE II.—SCREEN ANALYSIS OF HARDINGE BALL-MILL PRODUCT

	Per Cent.	Cum. Per Cent.
On 28-mesh	.0	.0
On 35-mesh	.1	.1
On 48-mesh	.4	.5
On 65-mesh	3.8	4.3
On 100-mesh	14.2	18.5
On 150-mesh	14.8	33.3
On 200-mesh	6.3	39.6
Through 200-mesh	60.4	
	100	

The average tonnage handled in Section 6 by the three mills during the month of January, 1918, was 987 tons per day of 24 hours. The power consumed in grinding by the three mills according to wattmeter readings amounted to 7475 kw.-hr. per day, equivalent to 7.57 kw.-hr. per ton. The power consumption for the balance of the work done in the total reduction from mine rock is very small. We have no accurate wattmeter readings on this, but according to our regular power distribution, figured from ammeter readings, the power for preliminary coarse crushing, conveying and operation of the Dorr classifiers amounts to 1 kw.-hr. per ton. Therefore, the total power consumption from mine rock to finished product is 8.57 kw.-hr. per ton.

Theory and Practice of Ball-Milling with Peripheral Discharge Mills, by PIERRE R. HINES. These notes were based on observations made by the author on a western trip made for the purpose of studying the ball-mill. He finds that balls fall from their maximum free height when the ball charge is about one-third the volume of the mill, and that the greatest number of tons crushed to a certain mesh per kw.-hr. is obtained under that condition. Capacity depends upon fineness of grinding, weight or volume of ball charge, hardness of material, size of grate openings and size of balls, other factors remaining constant. Tonnage and fineness are inter-related and the capacity of a ball-mill should be figured on the following basis when sufficiently reliable figures have been collected. The kw.-hrs. required to crush a ton of ore from and to a certain mesh should be arrived at from average operating conditions. A ball-mill has a certain definite maximum power rating depending upon its ball load. Multiplying the kw.-hrs. per ton by the tons required to be crushed per hour, the product will represent the power required, and the mill nearest to that power rating should be selected. For ball-mill feeding he recommends an apron feeder controlled by a variable-speed transmission device, and a smooth trunnion liner tapering into the mill. For fine grinding the best ratio of water to solids is 1:2 or 1:1½. Ball consumption varies with conditions of ore and grinding, but is about ½ lb. per ton for steel balls and 1 lb. for cast composition balls, when the product all passes 8-mesh and contains 10 to 20 per cent below 200-mesh, the mill running in open circuit. Average consumption of liners, for both chrome and manganese steel, is 1/3 lb. per ton of ore crushed, being fairly constant regardless of conditions.

New Method of Separating Materials of Different Specific Gravities, by THOMAS M. CHANCE. This paper

was presented by Mr. H. M. Chance, who gave a demonstration with a small experimental device. The method is based on the fact that fine sand mixed with water can be maintained suspended in the liquid by continuous agitation, and that this agitated mixture will act like a fluid of high specific gravity, including its ability to float solid bodies of less specific gravity and permit those of greater specific gravity to sink in it. In the apparatus exhibited, agitation was produced hydraulically by pumping water through the sand, and a mixture of coal and slate was readily separated. The method is believed to be of wide application in the mineral industry, and is about to be applied in coal washing.

The last milling paper presented at this session, on the United Eastern Mill, by OTTO WARTENWEILER, was published in this journal, Dec. 1, 1917, page 656.

SESSION ON IRON AND STEEL

The Erosion of Guns, by HENRY M. HOWE. This paper is based on the examination of two rings from an eroded gun liner. It treats of the hardening of the bore by its rapid cooling by the outer metal, the cumulative cracking of the bore, and possible palliatives of erosion. The phenomena are explained by assuming a "temperature cycle," or course of heating and expansion in each round. Following is an extract of the author's summary:

At any section the cycle begins with the passage of the driving band of the projectile, from which the lips of each crack, hardened in the preceding round and still cool, bite off a mouthful of copper, thus sealing themselves. Next comes extremely rapid heating, expansion, and closing of the cracks, with extrusion of much of the copper. A thin layer of the bore face is melted and swept forward by the rush of the gases, together with so much of the metal outside it as is heated to erodible mobility, the metal removed from any one section being thus replaced in part by that swept forward from rear sections, and this forward sweeping layer keeping all cracks sealed till the bore-face metal again hardens. With this forward sweeping probably goes the entrainment of some of the molten metal in the form of a mist, its bodily removal from the gun, and choke-boring. Thus the erosion at any given section consists first of this misty entrainment, and second of excess of metal swept forward from that section over that swept to it.

In the heating period, brief as it is, some of the initially distinct particles of ferrite and cementite in a very thin layer adjoining the bore face merge to form austenite. The following cooling by conduction into the cold outer metal is so rapid that this austenite is caught in the state of martensite and is thus hardened. It is next annealed during the heating period of the next round and in part eroded and re-hardened in the following cooling. Thus the hardening is repetitive.

The thickness of this hardened layer increases asymptotically from round to round, because the heating in each round extends beyond the layer actually hardened in the ensuing cooling, and in thus extending begins the merging of the ferrite and cementite beyond the layer hardened, and thus facilitates further merging and thus hardening in the next round.

In the cooling of each round the layer which has been fluid or at least pasty cools and hence contracts much more than the outer and cooler metal with which it is integrally united, and thus becomes in effect stretched by the resistance of this strong outer cold metal beyond its ability to retain continuity, and thus cracks.

In the grooves the expansion has to be axisward solely, and the cracking in the subsequent cooling is, therefore, about the same longitudinally as circumferentially. But the forward rush of the gases exaggerates the longitudinal cracks, so that the longitudinal ones are more prominent than the transverse. The expansion of the lands occurs both axisward and circumferentially, and the corresponding circumferential contraction in large part relieves the tendency to form longitudinal cracks, with the result that the main cracks are transverse.

The copper stopping of each crack, and the oxidation of its sides during the period of contraction, cause the cracking to be cumulative, so that the total width of the cracks, including their copper stoppings, is about ten times that corresponding to the contraction occurring in a single round. The transverse cracks on the strongly pressed lands are so much more prominent than those in the grooves, and have such an approach to even spacing, as to suggest strongly that they are exaggerated by chattering.

In the forward lands many of the cracks are filled flush with copper. The rest are black and not filled flush. A copper network projects from the forward grooves. The difference is referred jointly to the continuation of the expansion in the grooves till a later period than in the lands, and to less violence of the gas-rush in the grooves than on the lands, with the result that all the copper ejected by the expansion from the land cracks is wiped away by the gases, while the latest extruded from the groove cracks persists.

The cracking of the bore probably neither hastens erosion nor weakens the gun.

White-hardness and also great thermal conductivity, specific heat, and density, should lessen erosion.

Of the palliatives of erosion, the replacement of the liner seems the most promising.

Though experiments with other alloys of high melting point should be tried, the prospect of success is not great, because the available metals more infusible than iron are thought to yield alloys less infusible than it, and also difficult to machine, costly, and prone to oxidize.

The success of manganese steel in pipe balls in resisting conditions closely like those of gun liners suggests experimenting with it.

Dr. Howe's paper was discussed at length by naval engineers and others, but lack of space prevents publication of the comments.

Transverse Fissures in Steel Rails, by J. E. HOWARD. This paper dealt with fractures in steel rails at right angles to their length. The author regarded them as a modified type of fatigue fractures of interior origin. He explained their occurrence in the light of common knowledge on the behavior of steel under repeated alternate stresses. "By reason of the state of internal compression at the running surface, the maximum tensile stresses in the head, under bending loads, were along an interior element. Here the tensile strains were higher than in the fibers, more remote from the neutral axis. Under such conditions the fracture of the rail would be expected to have an interior origin." The author further stated that neither chemical analysis nor microscopic examination showed a definite cause for development of transverse fissures, and that such fissures developed in rails structurally free from any known defect. The fissures are found where traffic, wheel loads and speed have increased and where these conditions are well advanced.

Considerable discussion was elicited by this paper. Mr. WEYMOUTH found that most rail failures due to transverse fissures occurred in rails of extreme chemical hardness, and suggested adopting rails of different compositions for specific duties. Mr. UNGER suggested the following remedies: (1) Proper support of the rail to prevent alternate stresses; (2) decrease of the load on rails, and (3) an increase in the section of rails. Dr. DUDLEY did not accept the author's conclusion of the origin of transverse fissures and did not believe they were fatigue fractures. Mr. RAY believed that mill practice greatly influenced the development of transverse fissures and thought more attention should be given to the manufacture. He had found that these fissures developed mainly in rails of 0.80 carbon or above.

SESSION ON METALLOGRAPHY

This session was marked by the presentation of a number of highly technical papers which can scarcely be presented in brief abstract. Metallography is making rapid progress under the direction of a comparatively small group of brilliant investigators, and the metallurgical industry will find itself deeply indebted to them as time goes on.

Grain-Size Inheritance in Iron and Carbon Steel, by ZAY JEFFRIES. The author elucidated the following general laws influencing grain size, and illustrated his discussion by citing actual examples.

The grain size of any transformation product in iron and carbon steel due to heating or cooling through the transformation range will depend on:

A. The rate of heating or cooling through the transformation range.

B. The grain size and arrangement of the constituents just prior to the occurrence of any transformation.

C. The chemical and physical composition of the iron or steel product, i.e., carbon content, sonims, gas inclusions, blow holes, etc.

D. The temperature gradient obtaining during the transformation period.

The Time-Effect in Tempering Steel, by A. E. BELLIS. The author discussed the relation of reheating to physical properties and machinability of steel, particularly rifle-barrel steel. Tests are cited to show that increasing the time of reheating increases the ductility, toughness and machinability of the particular steels described.

Some Structures in Steel Fusion Welds, by S. W. MILLER. This paper is a discussion of conditions observed under the microscope in sections of oxy-acetylene and electric arc welds. It must be studied in connection with the microphotographs.

Effect of Copper in Steel, by CARLE R. HAYWARD and A. B. JOHNSTON. A synopsis of this paper appears in this issue, page 260.

Session on Employment Problems. A new departure was inaugurated at this meeting in the form of two sessions on employment problems. The growing importance of this subject has been realized by the institute, and programs were arranged covering all phases of the labor problem. Some of the points emphasized were the necessity of a thoroughly capable employment manager, adequate living conditions for labor and proper care of workmen while on duty. Other interesting topics concerned the training of workmen for better positions and the crippled soldier in industry. All of the papers are worthy of careful study.

Patent Office Improvements.—A composite committee has been created by the National Research Council to make a preliminary study of the problems of the United States patent office and its service to science and the useful arts. This committee comprises L. H. Baekeland, W. F. Durand, Thos. Ewing, Frederick P. Fish, Robert A. Millikan, E. J. Prindle, Michael I. Pupin, S. W. Stratton. Those interested in making any patent-reform suggestions are advised to forward them at once to Dr. Wm. F. Durand, National Research Council, Washington, D. C. The particular point upon which suggestions are desired is the manner in which greater efficiency and work of higher quality can be secured in the Patent Office.

Spring Meeting of the American Electrochemical Society

At a meeting of the board of directors of the American Electrochemical Society held in Philadelphia on Feb. 22 it was decided to hold the spring meeting in the South during the week of April 28. In accordance with plans previously proposed, the society will make a trip of one week through the chemical, electrochemical and metallurgical centers of the South. Over eighty members and guests have agreed to go. The society was urged by Southern members, heads of industrial concerns and railroad officials not to abandon this trip, all agreeing that it would afford a timely opportunity to study the present development and future resources of the South with respect to national needs. Railroad officials anticipate no difficulty in arranging transportation.

It is planned to leave Washington, D. C., Sunday evening, April 28, and spend one day in each of the following centers or districts: Kingsport, Knoxville and Chattanooga, Tenn., Sheffield and Birmingham, Ala. Programs of technical papers will be presented each evening. On the return trip the party will arrive in Washington Sunday, May 5, in time for individuals to reach their homes Monday morning. Arrangements are in charge of a committee headed by Mr. C. F. Roth, who may be addressed at Grand Central Palace, New York City.

Engineers in Government Service

THE Engineering Council, through its American Engineering Service Committee, has during the past few months supplied to various government departments and bureaus in response to their requests several thousand names of engineers from which men were to be selected to fill a great variety of positions in uniformed and civilian service for Army and Navy and other branches of the government's activities in connection with the war, as well as for indirect service for manufacturers and contractors engaged upon government war work.

To meet these demands the American Engineering Service Committee has assembled in its offices in the Engineering Societies Building, New York, extensive lists and much detailed information concerning engineers in all branches of the profession throughout the length and breadth of the land. It will readily be appreciated that if these lists are to be maintained in the most useful condition to the government and the Engineering Council, the committee should receive promptly information concerning each engineer who has gone into any kind of government service, direct or indirect, so that a record may be made on his cards in the committee's office.

Engineers reading these lines, to whom this request applies, are urged to send at once their names, present addresses and occupations in the government service, with brief statement as to whether or not they are available for other service, to American Engineering Service Committee, Room 901, 29 West 39th Street, New York. Other readers are asked to bring this request to the attention of such engineers or to send information directly to the committee at the above address.

Ultraviolet Energy and Its Use

By M. LUCKIESH

Physicist, Nela Research Laboratory

SINCE the discovery of ultraviolet rays, more than a century ago, their production and properties have been subjected to a great deal of investigation. However, notwithstanding the extensive literature on the subject, we must agree with Sheppard, who says in his book on Photo-chemistry: "We are only at the beginning of the conscious utilization of the powers of light, as distinct from the unconscious enjoyment of them." Owing to the many unique properties of these invisible rays they are extremely valuable in certain scientific investigations, tests, and industrial processes, and it appears certain that, with the progress of the development of sources of ultraviolet rays, and of media transparent to them, the usefulness of ultraviolet energy will be rapidly extended. The problems in which these unique properties may be utilized are so manifold, it appears that a general discussion of the subject may be welcomed at this time. For the sake of clearness in the following discussions, the spectrum will be divided arbitrarily, as follows:

Visible spectrum extends to wave-lengths slightly shorter than 400μ .

Near ultraviolet will designate the region between 400μ and 300μ .

This may be said to be the extent of the ultraviolet spectrum ordinarily encountered because clear glass is, in general, opaque to rays of shorter wave-length.

Middle ultraviolet will designate the region between 300μ and 200μ .

Schumann region is that from 200μ to beyond 100μ . This region has been studied elaborately by Lyman¹, who has revealed the spectrum somewhat beyond 100μ .

It is understood that some of these divisions and limits have been chosen arbitrarily for the sake of convenience in the present discussion.

TRANSPARENCY OF MEDIA

The transparency of various media for ultraviolet rays is of importance from the standpoint of the production, measurement, and utilization of this energy. Enclosing media and optical parts must be transparent to the rays to be utilized. Ofttimes filters are desired for isolating certain spectral regions and in many other ways it is of interest to know the spectral transmission characteristics of various media. Of course, the thickness of the medium is an important factor, but where this is not mentioned in the following discussion, ordinary moderate thicknesses will be assumed. In this general discussion it is out of the question to take up this and many other details.

Clear glass varies in its spectral characteristic in the ultraviolet region, depending upon its composition. Most ordinary clear glasses are quite transparent down to 350μ , but they usually decrease in transparency from this point until they become practically opaque at about 300μ . The Jena works developed a glass

(uviol) which transmitted quite freely down to 300μ . Fritsch² has given a formula for a durable glass which he claimed to be transparent as far as 185μ . He recommended 6 grams of CaF_2 , mixed with 14 grams of B_2O_3 in powdered form. This was melted in a platinum furnace crucible and poured out on an unheated sheet of platinum.

Fused quartz transmits freely to about 220μ . Crystal quartz is transparent as far as 180μ . It is thus seen that quartz is only useful for the middle and near ultraviolet regions.

Fluorspar is not only transparent to these regions, but also to nearly all the Schumann region, its transparency extending to 120μ .

Air absorbs the rays in the Schumann region quite powerfully. Therefore, for most practical purposes quartz is satisfactory. An air-path 1 cm. long is opaque to radiant energy of wave-lengths shorter than about 170μ . The solar spectrum, even when photographed at high altitudes, ends at about 290μ , indicating the presence of media in the earth's atmosphere or in that of the sun which are opaque to the rays in the middle and Schumann regions. Lyman presents data on the absorption of gases which may be of interest in this connection.

Snow reflects the near ultraviolet rays almost completely.

A thin veil of smoke is opaque to the middle and Schumann regions.

Gypsum, celestite, borite, sugar crystals, calcite and alum are opaque to most of the Schumann region, their transparencies ending in the neighborhood of 170μ .

Mica strongly absorbs the rays of short wave-length.

Rock salt is of high transparency at 185μ .

Gelatine strongly absorbs the rays of shorter wave-length than 200μ and therefore, for photographic work in this region, non-gelatine plates must be used. It is obvious that an evacuated space also must be provided owing to the absorption by the air.

Pure water is quite transparent to the middle and near regions.

The above-mentioned substances are of interest largely owing to their transparency but certain filters are of special interest owing to their spectral absorption characteristics.

Many optical glasses which are nearly colorless or of a yellowish-green or yellowish tint effectively absorb nearly all the ultraviolet region. Uranium glass is very effective in this respect and by virtue of its fluorescence it is useful in exploring an ultraviolet spectrum especially for such a purpose as focussing a spectrograph. Quartz spectroscopes are sometimes equipped with such fluorescent screens in the eye-piece for visually inspecting the ultraviolet spectrum. A solution of quinine sulphate or of aesculine effectively absorbs the ultraviolet rays and both fluoresce.

Dense cobalt-blue glass combined with an aqueous

¹Spectroscopy of the Extreme Ultraviolet. Longmans, Green & Co., 1914.

²Phys. Zeit. 8, 1907, p. 518.

solution of CuSO_4 (which absorbs the red band transmitted by the cobalt glass) isolates the near ultraviolet and violet rays.

Nitroso-dimethyl-aniline dissolved in water is fairly transparent between 280μ and 400μ . This may be incorporated in gelatine (6 grams of gelatine to 100 grams of water heated to about 50 deg. C.) and flowed on a glass or quartz plate. The best strength of this filter is one which just eliminates the blue and violet light. This filter may be combined with blue uvio glass and an aqueous solution of CuSO_4 for the purpose of isolating the near ultraviolet. In case the glass elements of such a combination are unsatisfactory, quartz plates may be used and a dense solution of methyl violet or other deep violet dye may be substituted for the blue uvio glass.

Many combinations of aniline dye solutions or gelatine filters may be used for isolating the near ultraviolet.* For isolating portions of the middle and Schumann regions various gases and other media may be used. For example, Peskov⁴ studied the spectral absorptions of chlorine and bromine and found that, by varying a mixture of these two gases, he could isolate regions of the spectrum as narrow as 240μ to 250μ . These mixtures were found to follow Beer's law and, therefore, after having obtained the requisite quantitative data, the mixture for filtering a certain spectral range could be calculated.

Metallic silver is opaque to the ultraviolet except for a narrow range near 300μ to 340μ . Colloidal silver appears to have a spectral transmission characteristic which differs from that of the metallic film.

Absalom⁵ dissolved such metals as K, Na, Li, Cs, Rb, Ba, and Sr in ammonia and obtained blue solutions which had valuable properties as ultraviolet filters. These solutions were quite fugitive but with dry ammonia and freshly scraped metal, Cottrell obtained blue solutions lasting as long as several years. A general result of Absalom's work was that transparency far into the ultraviolet is much more commonly met with in the case of color due to colloidal metals than in the case of ordinary colored salts or aniline dyes. The limit of transmission for liquid ammonia is at about 240μ . In general for these blue solutions total absorption began in the neighborhood of 245μ .

Absalom used an arc between copper poles and a small quartz spectrograph and thus was able to photograph a spectral range between 500μ and 225μ . He presented the following wave-lengths in μ as those at which complete absorption commences:

Natural blue rock salt	Beyond 225μ .
Natural rock salt colored by cathode rays	Beyond 225
Natural rock salt colored blue by cathode rays	Beyond 225
Sylvite, white	Beyond 225
Chili saltpetre, ordinary white variety	351.2
Chili saltpetre, violet	324.8
Fluorspar, colored deep violet by cathode rays	Beyond 225
Diamond yellow	320
Diamond blue	315
Kunzite	305

*M. Luckiesh, Color and Its Applications. D. Van Nostrand Co., 1915, p. 51.

⁴Jour. Phys. Chem. 21, 1917, p. 386.

⁵Phil. Mag. 33, 1917, p. 452.

Garnet	402.3μ .
Zircon (hyacinth) red-brown	261.8
Zircon, decolorized by heat	244.2
Zircon, green	402.3
Zircon, yellow	402.3
Topaz, pale yellow	261.8
Topaz, dark yellow	229.4
Topaz, pale pink-brown	261.8
Topaz, blue	296.1
Emerald	320
Ruby	300
Tourmaline, green	351.2
Tourmaline, green-yellow	300
Tourmaline, pink	306.4
Spinel, blue	402.3
Spinel, purple	324.8
Spinel, pink	300
Kyanite, blue	320
Beryl, blue	327.4
Cordierite, blue-purple	324.8
Cairngorm	324.8

SOURCES.

There are many sources of ultraviolet energy but few are powerful enough to be widely useful. The ideal source, which emits a continuous non-banded spectrum of high intensity throughout the entire ultraviolet region, does not exist.

The incandescent solids such as the latest Mazda lamps emit a continuous spectrum of appreciable intensity through only a part of the near ultraviolet region. The sun emits a continuous spectrum of fair intensity as far as 295μ but this spectrum has many dark lines due chiefly to selective absorption by the sun's atmosphere.

The limelight and burning magnesium ribbon emit appreciable ultraviolet energy but not in sufficient amounts to offset the inconvenience attending their use. Of the present-day sources this leaves only the arcs, sparks, and vacuum tubes available for the more general work.

The mercury arc in glass is obviously limited in usefulness by the absorption of the glass. Consequently the mercury arc in quartz tubes is much more applicable to ultraviolet work. This arc has the great advantage of steadiness but the disadvantage in some cases of large gaps in its line spectrum. Investigation has shown that the output of ultraviolet energy decreases materially with the time that the arc has been used, some old quartz mercury arcs being only half as effective as they were when new. However for many problems this arc is very satisfactory.

The ordinary carbon arc emits a considerable quantity of ultraviolet rays in the near and middle regions but there are other arcs which are far superior to it and are no less convenient to use. The magnetite arc has a positive pole of copper and a negative pole consisting of a sheet steel tube packed with a fine powder consisting principally of oxides of iron (magnetite), titanium, and chromium. This arc is fairly rich in ultraviolet rays.

Measured from the standpoint of total ultraviolet energy per unit of visual intensity of illumination, Bell⁶ ranks these sources in the following order: magnetite arc, old mercury arc, new mercury arc, and car-

⁶Elec. World. Apr. 13, 1912.

bon arc, the last two being about equal on this basis and more than twice as rich in ultraviolet rays as the first two. This basis is of interest in lighting but it should be noted that, in general, the ultraviolet output per watt of energy input is generally of interest.

Some spectra of interest will be found in Reference 3 and many emission spectra are to be found in the Atlas of Emission Spectra by Hagenbach and Konen. Atlases of absorption spectra have been prepared by Uhler and Wood and by Mees which show the absorption spectra of many soluble coloring media.

Lyman¹ has shown that the mercury arc emits a strong line near 185μ which will be very effective, in some reactions, with a short air-path but only feeble with a long air-path owing to the absorption by the air. This indicates that, when dealing with radiation of such short wave-lengths, very different results may be obtained with the same source depending upon the distance of the reaction from the source.

The flame arc has potential possibilities as a source of ultraviolet rays owing to the diversity of materials with which the carbons may be impregnated. It has been found that the feebly luminous flame of the ordinary carbon arc is the source of much of the short-wave ultraviolet energy emitted. The white-flame arc² of high amperage, in proportion to the energy input, is the most efficient commercial source of near and middle ultraviolet energy available at present. It radiates energy quite extensively in the near and middle regions. Mott found the fading effect on dyes at a distance of 10 inches from a 28-ampere white-flame arc to be several times greater than June sunlight and that the fading results were approximately the same. Obviously there should be no rays present of shorter wave-length than 295μ in a dye-testing illuminant if the results are to be comparable with that of sunlight. Such a source as the white flame arc could be screened by a thin glass shell of a proper spectral transparency in order to eliminate rays of those wave-lengths not found in daylight.

The blue flame arc emits ultraviolet energy very strongly.

It is a simple matter to construct an arc which will emit ultraviolet energy strongly, provided hand-control is satisfactory. An iron rod and a carbon rod may be employed successfully for the two poles, however, two iron rods may answer the purpose very well. These poles may be kept cool effectively by means of heavy brass or copper sleeves which may be moved along the iron rods as the latter are consumed. A particularly successful iron arc of this type can be made in a few hours. The upper pole, which is negative, may be an iron rod about $\frac{1}{4}$ -in. in diameter. This is surrounded by a movable but well-fitted solid sleeve of copper about one inch in diameter. The lower pole may be an iron rod about $\frac{1}{2}$ -inch in diameter with the end in the form of a shallow dish. One pole should be adjustable vertically. In preparing the arc a bead of molten metal is developed in the dished end of the lower electrode, the latter becoming oxidized, which apparently decreases the rapidity of deterioration. The upper electrode is well cooled and the arc is maintained very steadily between the molten bead of iron and the upper solid electrode. The writer has had such an arc operate at a rather

high current density for thirty minutes without any adjustment. The dimensions may be increased to meet the requirements. It is not a difficult matter to make various simple arcs which are quite satisfactory for a great deal of work.

For many purposes the spark between metallic electrodes is very satisfactory but, in general, the sparks can not compete with the arcs in quantity of ultraviolet energy emitted. Various forms of spark gaps have been employed depending upon the requirements; usually steadiness of position of the spark and shadows of the poles are the factors which determine the shape of the gap. A short spark obtained from a transformer may be satisfactory or it may be fattened by using a condenser. A high frequency spark may sometimes be desirable. The kind of spark obtained depends upon dimensions and electrical relations and obviously these may be widely varied. The metals commonly employed for the poles of spark gaps are aluminum, zinc, iron, copper, and cadmium, although any other may be satisfactory, depending upon its spectrum and upon the specific requirements.

The spectra of electrically excited gases confined at low pressures in transparent tubes have been extensively studied but such vacuum discharge tubes have found little or no use in industrial processes. They have provided sources of extreme value in some investigations. The spectrum of hydrogen under these conditions exhibits many lines and bands in the Schumann region. These tubes are usually of the capillary type and contain the gas at low pressures of the order of magnitude of one mm. of mercury. Obviously, in order to be useful in the extreme short-wave region, they must be provided with a fluorite window.

Lyman³ has studied the spectra of various gases in the Schumann region. It is interesting to note that the character of the circuit and discharge influences the spectra of some gases very much. For example, argon yields no lines shorter than 190μ in wave-length with no capacity in the circuit. By using a disruptive discharge a considerable number of lines appear throughout the Schumann region.

PROPERTIES.

The effects of ultraviolet energy are too numerous to discuss at length in this article but a few will be noted briefly. The chemical changes in silver salts are well known and have formed the basis of the extensive developments of photography. Draper enunciated a law for photo-chemical reactions which states that only the light absorbed is chemically active. The converse of this law—that every substance which absorbs light undergoes chemical change—apparently is not true. An aqueous solution of an inorganic salt, for example, CuSO_4 , strongly absorbs yellow and red rays but is not altered chemically by these rays. Bichromate salts which absorb blue, violet, and ultraviolet rays are stable by themselves but in the presence of organic substances the bichromate is reduced, that is, photo-chemical action obtains.

Ultraviolet energy is in general superior to visible rays in the production of fluorescence and phosphorescence. In fact under powerful ultraviolet rays it is almost impossible to find substances which do not fluor-

¹W. R. Mott, Amer. Electrochem. Soc., 1915. Mott and Bedford, Jour. Ind. and Eng. Chem. 8, 1916, 1029.

²Astrophys. Jour. 3, 1911, p. 98.

esce to a slight degree at least. One of the most interesting experiments is found in focussing an intense ultraviolet spectrum in a horizontal position in space and bringing various substances in this plane. In this position the surfaces of solutions such as aniline dyes may be brought into the focussed spectrum. It is very interesting to note the rays which are most effective. In the case of phosphorescent materials, the regions which cause fluorescence alone may readily be distinguished from those which produce the more permanent glow. Even different colors of the resulting luminescence may be distinguished at different spectral regions of the exciting radiation. According to Sheppard, all organic bodies possessing strongly marked absorption bands in the ultraviolet, seem capable of either fluorescence in a dispersed condition or phosphorescence in a condensed condition when excited by ultraviolet energy of a proper frequency or wave-length. There have been applications of luminescent analysis to mineralogical and botanical research. This entire field of phosphorescence and fluorescence offers many opportunities for pioneer investigations.

When polished metals, such as zinc, are illuminated by ultraviolet energy they become positively charged if insulated. If negatively charged they become discharged. Under the influence of the rays, negative electrons are discharged from the metal. The breakdown voltage of an air-gap is decreased when illuminated by ultraviolet rays. Some of these phenomena may be accounted for by the ionization of the air but many metals emit electrons under certain conditions when illuminated by ultraviolet light of sufficient intensity. This latter effect is known as the photo-electric phenomenon. Even the dust particles in the air exhibit this photo-electric effect. The alkali metals are especially sensitive in this manner to visible rays as well as to ultraviolet rays. The photo-electric cell has become a valuable measuring instrument for those rays to which it is sensitive.

Ultraviolet energy is of interest from the standpoint of the permanency of coloring media because it is especially destructive in this respect.

Lithopone is darkened by these rays as is easily seen by projecting an intense ultraviolet spectrum upon a lithopone surface. By using quartz lenses and projecting the image of an arc on such a surface, the darkening was perceptible almost instantly, although it required many minutes of summer sunlight to cause the same darkening. This is a simple method of obtaining an intense concentration of ultraviolet energy which is useful in many processes and tests.

Ultraviolet energy accelerates the chlorination of natural gas in the manufacture of chloroform and hastens other processes. Blue and violet light are also effective in causing or hastening many chemical reactions.

Short-wave energy even in the near ultraviolet region is effective in changing the color of glasses especially those containing manganese. Under the influence of the radiation from the mercury arc some of these clear glasses containing manganese will assume a purplish tint after a few hours of exposure.

Ozone is readily produced in the vicinity of a powerful source of ultraviolet. It is believed by some that the solar spectrum ends at about 295μ on the short-

wave end, due largely to ozone which absorbs maximally at 255μ . Of course, smoke and various gases play some part.

Pure water is quite transparent to the near and middle regions but tap water is ordinarily slightly absorbing. Pidduck⁹ studied very dilute solutions of salts commonly found in tap water and found distinctly different transparencies for ultraviolet although the absorption was not very great in any case.

The ionization of air by ultraviolet rays has led some to believe that the electrons or ions provide nuclei for the condensation of water vapor and thus ultraviolet energy may play a part in rainfall. Dust particles may very well serve as nuclei, and in this connection the classic experiment of artificial production of clouds by providing various kinds of nuclei is interesting.

Ultraviolet energy is very powerful as a bactericidal agent, the disinfecting property of sunlight being one of the first principles of hygiene and sanitation. Consecutive days of rain, mist or fog permit the growth and development of pathogenic organisms.

Owing to the transparency of water to the ultraviolet rays emitted by the quartz mercury arc, the latter is in use for killing germs in water. The water is usually filtered if it contains much solid matter in order that germs may not escape death in the shadow of a suspended particle.

Some medical authorities believe that ultraviolet rays are of greater value as a curative or bactericidal agent when associated with the blue and violet rays or even with the whole spectrum.

The effect of ultraviolet energy upon animal tissue is indicated by the bronzing of the skin and especially by the destructive effect upon the membranes of the outer eye. The cornea is opaque to all rays of shorter wavelengths than about 295μ , therefore none but the near ultraviolet rays can reach the retina. But the lens is not transparent as far into the ultraviolet as the cornea. Owing to the industrial processes, such as acetylene and arc welding, which are attended by powerful ultraviolet energy, there is a demand for eye-protecting glasses. To develop such glass and to test the finished product, spectroscopy of the ultraviolet is necessary. Visual inspection cannot be depended upon for determining the satisfactoriness of eye-glasses in absorbing the ultraviolet rays.¹⁰

MEASUREMENT

Although much valuable information can be obtained by qualitative experiments, oftentimes it is necessary to measure at least the relative amounts of ultraviolet energy. There are many methods available; in fact, many of the properties of ultraviolet rays may be employed in measuring the intensity of the invisible energy provided a relation between effect and intensity is established.

The photographic plate is perhaps more generally used than any other method. Relations between intensity of the radiation, exposure, and photographic action or plate density must be established for the radiation to be measured. Owing to the opacity of gelatine in the Schumann region it must be eliminated

⁹Phil. Mag. 17, 1909, p. 710.

¹⁰Luckiesh, Trans. Illum. Eng. Soc. 9, 1914, 472.

or greatly reduced in amount if this region is to be investigated photographically. Schumann adopted a special process of making silver bromide emulsions very weak in gelatine. His plates were sensitive to the short-wave region but not to radiant energy of longer wave-lengths than 300μ . The photographic plate is perhaps the only means used for detecting ultraviolet energy of the shortest wave-lengths.

For certain regions the electroscope has been employed because of the leakage of its charge when connected to a piece of clean zinc which is illuminated by ultraviolet energy.

The photo-electric cell is sufficiently sensitive for spectral analysis in the near and middle regions but the relation between current and intensity of radiation must be established for the cell used. When cells are made according to certain specifications this relation has been found to be linear.

If the ultraviolet energy is sufficiently intense its

heating effect may be used as a basis of measurement. In such a case the bolometer, radiomicrometer, and thermopile may possibly be sufficiently sensitive under the best experimental conditions.

Owing to the large number of photo-sensitive reactions it is possible to devise various methods of measuring ultraviolet energy, at least relatively, for certain ranges of the spectrum depending upon the reaction chosen. These are too numerous to be discussed at length here.

It has been the aim to review the subject in general as it might interest the chemist. In doing this within the limits of a single article it has been impossible to discuss many aspects and excellent researches; however, in the few references given will be found many, others which will aid those who wish to pursue the subject further.

Nela Research Laboratory,
National Lamp Works of General Electric Co.
Nela Park, Cleveland, Ohio.

Problems of Wage Payment

By H. N. STRONCK

ONE of the most serious problems which industry is facing to-day is the problem of labor. Never before in the recent history of this country has there been such a scarcity of labor of all kinds, both skilled and unskilled. There is no outlook at the present time for an increase in the total number of labor units in this country, but there is every possibility that the scarcity will become greater and greater as time goes on and greater demands are made on the labor supply for Government service. The rate of wages in most industries is from 20 to 60 per cent greater than during the pre-war period and the effectiveness of labor at these much higher prices is far less than it was two or three years ago. To make matters worse, certain types of industries are able to give a much higher proportionate increase in wages than other concerns not so fortunately situated. As a result very keen competition has arisen in obtaining and holding labor of all classes from the highly skilled to the most ordinary type.

OBJECTS TO BE ATTAINED

The majority of industrial managers are aware of this situation and can see far enough into the future to realize that some very strenuous efforts must be made to stabilize these conditions, to meet the ever increasing wage scale and to obtain a labor turnover as small as possible. The problem resolves itself into three parts:

- (A) To hold the present working force intact.
- (B) To be able to obtain and hold additional workers.
- (C) To establish intensive training and co-operative methods so as to obtain the highest possible effectiveness of each labor unit.

RECENT PLANS

In order to hold the present working forces intact three general plans have come into vogue during the past year:

- (A) The payment of a so-called service bonus.
- (B) Insurance policies for workers.
- (C) Betterment of working and housing conditions.

Service bonuses are generally paid as a percentage of the present wages, and vary with the length of continuous service. A very popular one is the payment of a 10 per cent bonus at the end of every three months for continuous service during the period. Other popular ones are based on a sliding scale of 5 per cent for three months' service, 7 per cent for six months' service and 10 per cent for one year's service. The contention is that the average worker employed in such an industry will at least remain the full length of the service period. In some industries the majority of the departments are on some type of production payment plan, and in such departments or groups where conditions are such that a production plan cannot be introduced a service bonus is paid above the nominal wage scale in order to equalize the wages throughout the plant. Service bonuses have a good effect on the older employees and especially on such employees who have their homes established in that community. Service bonuses, however, do not have a very great effect on obtaining new labor especially of the nomadic class, who are easily influenced to shift when they find that higher base wages are paid in their line of occupation in other plants, even though these plants be located at some distance from the community. Service bonuses as a rule do not act as an incentive for increasing production, and hence one of the greatest objects to be desired is not attained.

Life insurance policies for workers have become very popular during the past year. The amount of insurance taken out for a worker and paid for by the company is usually based on the yearly wage of the employee and the number of years of previous service in the plant. This form of reward acts well on the older and more settled employees who have families or de-

pendents, but has practically no effect on new labor or on younger employees with no dependents. Insurance rewards do not act as a strong incentive or argument in the obtainment of new labor units.

With the advent of the dilution of male labor with female it has become necessary to arrange for far better working conditions. Otherwise no very strong bid can be made for obtaining and holding female employees for ordinary plant operations. The general effect of improving working conditions is very good. It eliminates certain frictions and grievances and the general tone of the plant is raised to a higher level.

PRODUCTION REWARDS

The desired result in all industries is to:

(A) Obtain maximum production from each unit of labor.

(B) Pay higher wages than those paid in competing labor markets.

(C) Have the lowest possible direct labor cost per unit of production.

(D) Keep wastes of material at a minimum.

(E) Have all methods work toward the ultimate benefit of both employer and employee.

The advent of systematic cost-accounting methods must be credited as being one of the most important influencing factors for the introduction of wage payment plans based on production and waste elimination. Cost-accounting methods analyze and bring to the attention of the management true present costs and abnormal conditions of cost. Knowing the present cost, it then becomes the desire to reduce these. As a result a great many methods, plans and schemes have been evolved and introduced for the attainment of this object.

The management soon realized that the most wasteful and ineffective method of wage payment was the day-work method. Therefore, day-work methods must be replaced by methods which are based on reward for effort expended. The chief difficulty encountered was in the design of some plan whereby the effort of practically all employees could be measured and the reward paid accordingly.

Profit-sharing plans were introduced as far back as 1842, had a good effect in certain instances, but in general did not attain the object desired because they did not include certain fundamental principles necessary for success.

ESSENTIAL POINTS OF WAGE SYSTEMS

Any system of reward to be highly effective must have the following points:

(A) The reward must be a definite and positive gain to the individual.

(B) The reward must be definitely known before the work is commenced.

(C) The reward must be personal; that is, the reward must be for that particular person, for that particular work.

(D) The individual must get exactly what was determined before.

(E) The individual must be positively assured that he will get the reward.

(F) As soon as the work is done the individual must get the reward.

PIECE WORK

Piece work, which was the most popular method until the efficiency movement reached its height, met the majority of these points. There is nothing wrong with the piece-work system in itself, but so many violations have taken place in the fundamental principles that the objects to be desired were not reached. Considerable dissatisfaction, grievances and many strikes have taken place. Piece-work methods are looked upon with great suspicion by the working classes. Regardless of whether or not piece prices have been cut in any particular plant, the inherent suspicion against piece work still remains in the minds of the workers, and one of the greatest of industrial wastes, the limitation of output, has been the result. With the present great fluctuations in labor market conditions it would hardly be advisable to introduce the very inflexible piece-work schemes. When it becomes necessary to pay higher wages, piece prices must be raised. If labor prices should decline, the only way the management could take advantage of this would be to reduce the piece prices. Also the principles of straight piece work do not guarantee a living wage. With the present ineffectiveness of labor and the introduction of female workers in industries, it becomes highly essential that, regardless of the output at the start, at least a guaranteed wage must be paid in balance with the daily wage scale in that district. From the standpoint of the management a piece price definitely fixes the direct labor cost per unit and there is no way of reducing the labor cost with high production unless the piece prices are cut.

BONUS PLAN

Since the desired object was not attained by the piece-work, profit-sharing, contract methods, etc., new methods have come into vogue, many of which have been very successful and have replaced the plans previously referred to.

Bonus systems in general are based on the principle of dividing the savings effected in some definite proportion between the management and the employees. The majority of these guarantee an hourly wage, specify some definite standard of output and pay a bonus, in some cases when this standard is reached, and in a good many others when this standard is exceeded. The accompanying Chart I compares various forms of the best known and the most popular wage-payment plans.

COMPARISON OF VARIOUS METHODS

In making this comparison certain assumptions were necessary due to the fact that different standards must be set for each type of plan in order to produce the same amount of remuneration for the same output at a certain point. In determining standards for any type of production wage-payment plan the two following questions must be answered:

(A) How much work can be performed by a first-class worker at a speed under which he will thrive?

(B) What extra inducement must be paid to this first-class worker for this output?

On the particular case in point it was found by a long series of experiments and by time and motion study that a first-class worker could produce 148 units of output per hour and deliver this output day after day and month after month without injury to himself. It was

also found that a reward of 30 per cent above the wage scale was necessary to induce the worker to produce this output. The normal wage scale on this operation was 20c. per hour. Therefore, for an output of 148 units per hour it became necessary to pay a bonus of 6c. per hour, or a new rate of 26c. per hour. Regardless of the wage-payment plan, this worker must receive 26c. per hour for an output of 148 units per hour. All curves must intersect at point "Q."

HALSEY 33 $\frac{1}{3}$ PER CENT PREMIUM PLAN (WAGE LINE GH)

Under this plan the worker receives as a bonus one-third of the value of the time saved. Example: If a worker's rate is 20c. per hour, a standard of 10 hours is set on a job, and the worker performs this in 7 hours, thus saving 3 hours, he would receive as a bonus one hour's time.

Because of the small part of the value of time saved paid as a bonus, the standard under this plan would necessarily be very low. As shown on this chart the standard would be 57 $\frac{1}{2}$ units per hour and at an output of 148 units per hour he would receive the 30 per cent extra inducement.

Owing to the fact that the workers' share of the savings is small, no great investigation is necessary to determine standards under this plan. In general under this plan the standards are estimated from previous costs, and as a worker reduces these costs he receives one-third of the savings.

HALSEY 50 PER CENT PLAN (WAGE LINE FL)

Under this plan the worker receives as a bonus one-half of the value of the time saved. Example: If a standard of ten hours is set on a job and the worker performed this in seven hours, thus saving three hours, he would receive as a bonus 1 $\frac{1}{2}$ hours' time.

Because there is a larger part of the value of the time saved paid as a bonus to the worker under this plan than under the Halsey 33 $\frac{1}{3}$ per cent, the standard set would need to be greater. Referring to the chart it will be seen that the standard under this plan would need to be 88 units per hour to bring the intersection at point "Q."

A greater intensive study of conditions and outputs must be made under this plan than under the Halsey 33 $\frac{1}{3}$ per cent. In a great many cases the standards under this plan are based on time study, while in many others they are based on previous estimates of cost, and as a worker reduces these costs he receives one-half of the savings.

THE TAYLOR SYSTEM (WAGE LINE RQN)

Under the Taylor system two piece prices are set, known as the low rate and the high rate. Under this comparison the high rate is 30 per cent greater than the low rate. The standard set would be 148 units of output per hour. For outputs less than this amount the piece price would be 20 per cent less than for an output of 148 units per hour or more. Under this system the reward is great when the standard is reached, but for a failure to reach this standard the penalty is severe. Under this plan only a first-class worker can reach standard and thus obtain the bonus. Under present industrial conditions of ineffectiveness of labor units but very few workers in the ordinary plant would be able

to reach the high reward under this plan. If it were possible to fill a plant at the present time with first-class workers this method of payment would act as the strongest possible form of incentive, but it would be far too difficult to introduce under present industrial conditions. Less than 10 per cent of the workers in the ordinary establishment would be able to take advantage of the high reward offered. Under this system great precision in rate setting and utmost standardization of operations are necessary.

GANTT SYSTEM (WAGE LINE XRQN)

The Gantt standard is the same as the Taylor; that is, 148 units of output per hour. Under this plan, however, applied to the case in point, an hourly wage of 20c. would be guaranteed regardless of the output. If the output reached 148 units per hour a bonus of 30 per cent would be paid.

Under this system the penalty for not reaching the output of a first-class man is not so severe. All workers are at least guaranteed a standard wage. The standard under this system must be set very accurately and conditions must be highly standardized. Only first-class operators would receive a bonus and hence such a system would effect but a small proportion of the employees in a plant under present industrial conditions.

STRAIGHT PIECE WORK (WAGE LINE AN)

Under straight piece work a definite price per piece would be paid regardless of the output. Under the case in point the piece price would be 0.176c.; that is, for an output of 148 pieces 26c. would be paid. If the output were less than 114 pieces per hour the worker would receive less remuneration than under any of the plans where the hourly rate is guaranteed at 20c.

THE EMERSON EFFICIENCY SYSTEM (WAGE CURVE BP)

Under the Emerson system the standard would be 138 units. A bonus of 20 per cent is paid, and the worker would receive 24c. per hour. The Emerson bonus, however, commences at efficiencies of 66 $\frac{2}{3}$ per cent, so that if the output exceeds 108 units per hour, some bonus is paid. The proportion of bonus paid takes the form of a parabola from the 66 $\frac{2}{3}$ per cent point to the 100 per cent or standard point. After the 100 per cent point has been reached, in addition to the 20 per cent bonus at 100 per cent, an extra 1 per cent bonus for each 1 per cent of efficiency increase above 100 per cent is paid. Example: If the efficiency is 110 per cent the bonus is 30 per cent.

The Emerson system is one of the most modern developments of bonus systems, has been given wide publicity through the writings of Mr. Harrington Emerson and has been applied in a great number of plants.

The standard under the Emerson system must be set with considerable care, as under the Gantt and Taylor systems.

ROWAN DIMINISHING PREMIUM SYSTEM (WAGE LINE CK)

This illustrates a typical diminishing premium system whereby rates are automatically cut at higher outputs. As under the others, a standard time is set and the worker receives his hourly wages for the time actually engaged on the job plus a premium figured on the actual time in proportion to the time saved to the

standard time. The formula for calculation of wages is

$$\left(\text{Time taken} + \left\{ \frac{\text{standard time} - \text{time taken}}{\text{standard time}} \right\} \times \text{time taken} \right) \times \text{hourly rate} = \text{Wages.}$$

Under this system the worker can never double his day wage, as the value of the controlling factor, which is

$$\frac{\text{Standard time} - \text{time taken}}{\text{Standard time}}$$

constantly approaches unity as the time consumed approaches zero. Hence, the premium can never exceed the day rate multiplied by unity. Under this system the workman soon learns that above a certain output the reward is not sufficient to warrant the extra effort on his part. Because of this, limitation of output is very frequent under this system. This system has been in use in a number of plants, but because of its many disadvantages was discontinued and replaced by more equitable plans.

There have been various modifications of the original Rowan plan and in many the decrease in price per piece has been much more rapid. By comparing diminishing premium plans with any equitable plan it will be noticed that a zone is formed between the diminishing premium curves and any of the curves of the equitable plans. Louis Ruthenburg of the Dayton Engineering Laboratories Co. (Delco), after an exhaustive study of a large number of payment plans, named this zone the "Zone of Deception."

Where this plan had been introduced the management had the feeling that it was impossible to set accurate standards and their fear was that workers would earn too high wages. With the advent of scientific rate setting by time and motion studies the danger of inaccurate standards has been eliminated so that there is no justification for introducing any diminishing premium plans.

As will be noticed from the chart, the standard set for the case illustrated would be 105 units of output per hour.

THE BENEDICT-STRONCK DIFFERENTIAL TIME BONUS SYSTEM. (WAGE CURVE EM $\frac{1}{4}$ PER CENT PRINCIPLE—WAGE CURVE DO $\frac{1}{2}$ PER CENT PRINCIPLE)

In formulating the principles and designing the application of these systems the object in view was to include the strong features of other wage systems and eliminate as many as possible of the weak points. The results obtained in practice by these methods have proven that this object has been attained.

These systems are based on certain fundamental principles and the design of the curves vary for different conditions without violating the fundamental principles. The fundamental principles on which these are based are:

- Guaranteed hourly rate known as the "base rate" below which the worker does not fall.
- A time allowance for each job known as the "standard time."
- A division of the value of the time saved from this "standard time" between the worker and the management on an increasing differential basis, in favor of the worker; that is, the greater the output the greater will be the proportion of the value of the time saved given as a bonus to the worker.

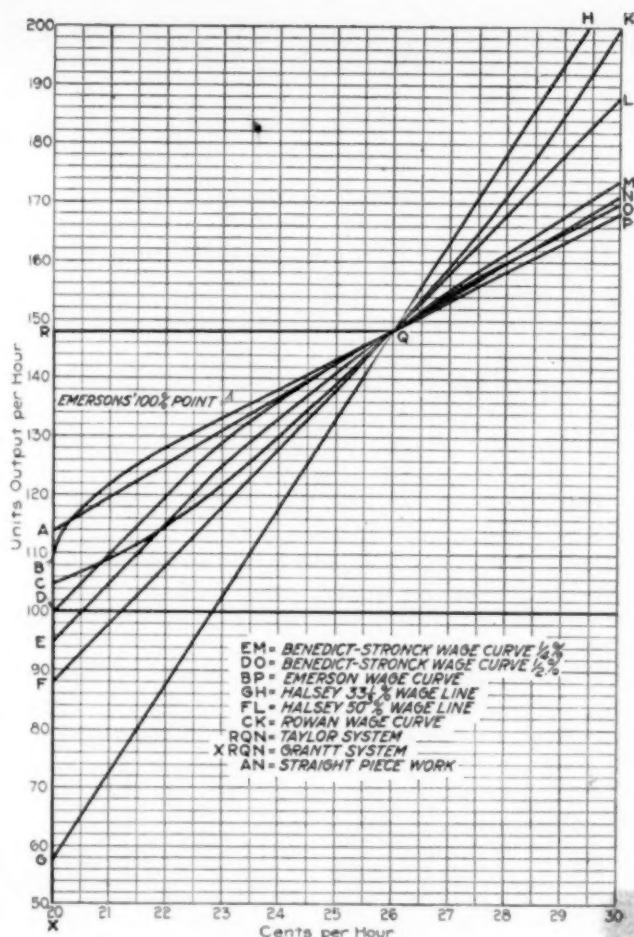


CHART I. COMPARISON OF WAGE-PAYMENT PLAN

The accompanying Chart II illustrates the details of the Benedict-Stronck differential time bonus system on the $\frac{1}{4}$ per cent principle. This illustration is designed according to the following mathematical principles:

For efficiencies of between 100 and 125 per cent the worker receives as a bonus one-half of the value of the time saved. This is equivalent to the Halsey 50 per cent principle.

For efficiencies above 125 per cent the worker receives as a bonus, in addition to half the value of the time saved, $\frac{1}{4}$ per cent of the value of the time saved for each per cent of efficiency increase above 125 per cent.

As will be noted, the differential parabola is connected with the 50-50 line at the 125 per cent point. The following two examples illustrate the detailed calculation of the new hourly rates:

(A) For a point less than 125 per cent in efficiency. (Refer to curve ABD)

ASSUME: Standard time = 10 hours
Base rate = 20 cents
Efficiency = 115 per cent

Then actual time of performance = $\frac{10.0}{1.15} = 8.70$

hours.

$10.0 - 8.7 = 1.3$ hours of time saved.

Value of time saved = $1.3 \times .20 = \$0.26$.

Bonus is one-half of this = \$0.13.

WORKER'S PAY: On base rate = $8.7 \times .20 = \$1.74$
 Bonus = .13

Total pay for 8.7 hours work \$1.87

\$1.87

Hourly rate for job $\frac{\text{---}}{8.7} = 21.5 \text{ cents.}$

(B) For a point on the parabola or above 125 per cent of efficiency:

ASSUME: Standard time = 10 hours
 Base rate = 20 cents
 Efficiency = 165 per cent

Then actual time of performance = $\frac{10.0}{1.65} = 6.06$

hours.

$10.0 - 6.06 = 3.94$ hours of time saved.

Value of time saved = $3.94 \times .20 = \$0.788$.

50-50 bonus is one-half of this = \$0.394.

Increase in efficiency over 125 per cent = $165 - 125 = 40$ per cent.

Additional bonus of one-fourth per cent of value of 40

time saved for each per cent above 125 per cent = $\frac{\text{---}}{4}$

= 10 per cent additional = $.10 \times .788 = \$0.079$.

WORKERS' PAY: On base rate = $6.06 \times .20 = \$1.212$
 50-50 Bonus = 0.394
 Differential bonus = 0.079

Total pay\$1.685

1.685

Hourly rate for job = $\frac{\text{---}}{6.06} = 27.8 \text{ cents.}$

The following formula applies to the curve of the $\frac{1}{4}$ per cent principle.

New rate per hours = R

Base rate per hour = R_1

Standard time = T_1

Actual time = T_2

$$R = \frac{R_1}{4 T_2^2} (T_1^2 - 0.25 T_1 T_2 + 3.25 T_2^2)$$

By referring to the "per cent saving in direct labor above margin" (curve AHC) it will be noticed that the direct labor cost keeps on decreasing and the maximum saving to the company in direct labor is at 180 per cent of efficiency. The zone of the maximum saving in direct labor to the company lies between efficiencies of 165 and 195 per cent. At these points of maximum saving to the company the bonus to the worker is from 39 per cent to 64 per cent.

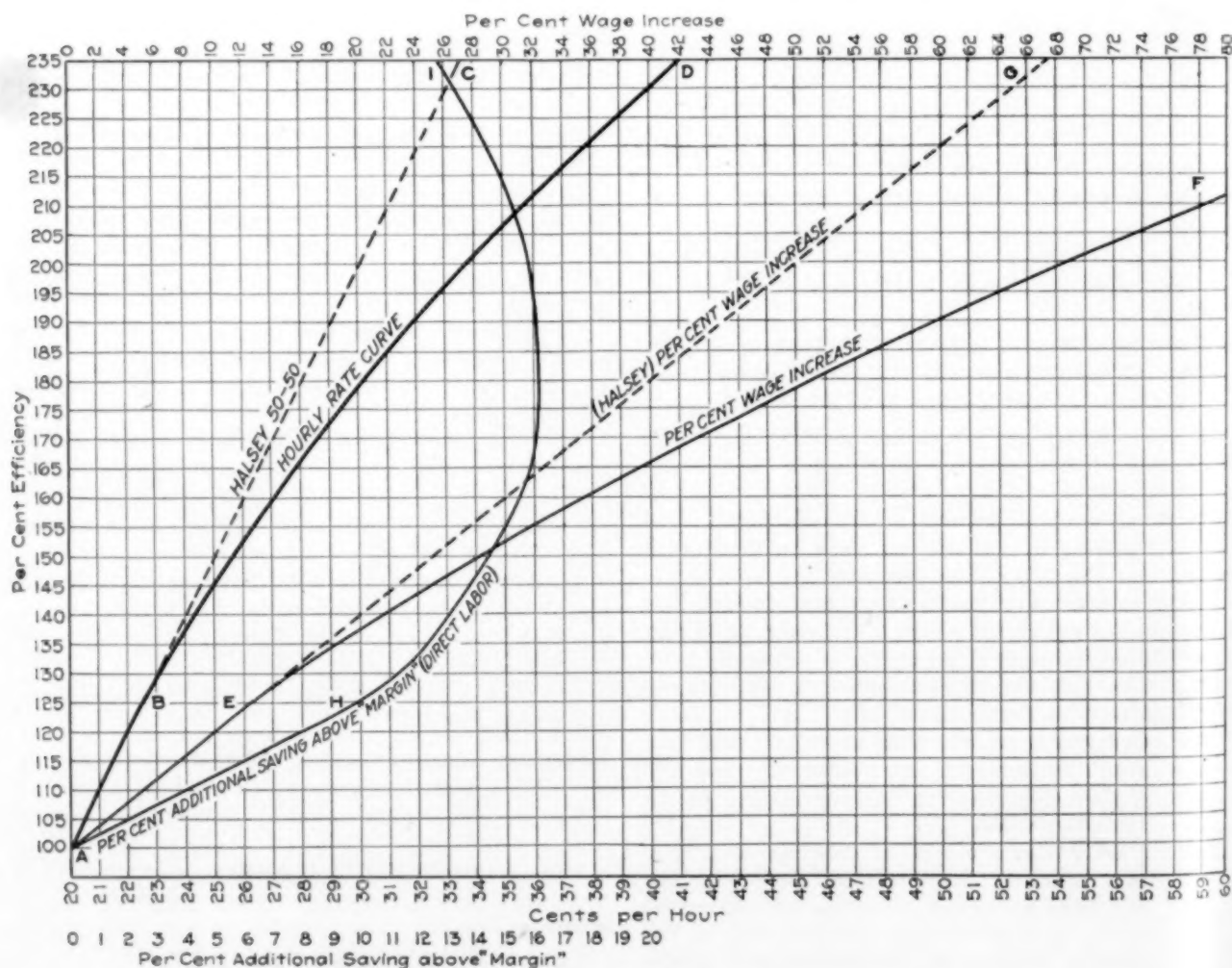


CHART II. THE BENEDICT-STRONCK DIFFERENTIAL TIME BONUS SYSTEM

Under this system, if it is assumed that a first class worker is to receive a 30 per cent extra inducement for working at his best, he would have to reach an approximate efficiency of 153 per cent.

The system under the $\frac{1}{2}$ per cent principle, as illustrated by curve "DO" on the comparison chart, is identical to that of the $\frac{1}{4}$ per cent principle up to the 125 per cent efficiency point: that is,

- (A) For efficiencies between 100 and 125 per cent the workers receive as a bonus $\frac{1}{2}$ of the value of the time saved.
- (B) For efficiencies above 125 per cent the worker receives as a bonus, in addition to half of the value of the time saved, $\frac{1}{2}$ per cent of the value of the time saved for each per cent of efficiency increase above 125 per cent.

Since the relative proportion of savings given to the worker increases more rapidly under this than under the $\frac{1}{4}$ per cent principle, the worker would need only to reach an efficiency of 148 per cent to receive a 30 per cent bonus.

As will be noticed, these systems have a great flexibility of design without violating fundamental principles. The parabola may be attached to the Halsey 50-50 line at any point. The slope of the parabola may be increased or diminished by calculations other than the $\frac{1}{4}$ or $\frac{1}{2}$ per cent principle, such as, a $\frac{3}{4}$ per cent or $\frac{1}{3}$ per cent principle.

The differential feature of these systems acts as one of the most powerful of incentives. Workers strive to attain high efficiencies because their proportionate reward is so much greater. Every worker in a plant, who is industrious and fitted to his work, can earn at least some extra reward under these systems. Therefore, these systems have a strong appeal.

APPLICATION

The actual application of these systems in practice is very simple. From the curves, a table is computed which shows the per cent bonus at the various efficiencies. This per cent bonus is always a per cent of the base hourly wage.

A standard once set, under this system, need not be changed to meet fluctuations in the labor market. Every advantage of these fluctuations may be taken by fluctuating the hourly rate at which workers are engaged. This is one of the strong points of this system and, hence, has become very popular in replacing inflexible methods.

In practice a standard time, or standard output, is very carefully determined by means of motion studies, time studies, and fatigue studies, taking into consideration all economic, psychological and sociological factors entering into the problem:

Efficiency is determined in either of two ways:

Standard time

$$(A) \frac{\text{Actual time}}{\text{Standard time}} = \text{Efficiency per cent.}$$

Actual time

Actual output

$$(B) \frac{\text{Standard output}}{\text{Actual output}} = \text{Efficiency per cent.}$$

Standard output

BY-PRODUCTS

There are many very valuable by-products of these bonus systems:

- (A) The standard time gives precise information

as to outputs of various operations and, hence, is invaluable in determining plant capacities and the layout of scheduling methods.

- (B) The standard times also give standard costs of labor which are of great value for cost accounting and estimating purposes.
- (C) A direct comparison can be made of the personal effectiveness of each labor unit regardless of the kind of operation.
- (D) Weak points in personnel are easily determined and brought to the attention of the proper official, so that proper remedies can be applied consisting generally of more intensive training or shifting to operations for which the worker is better adapted mentally and physically. The writer has come in contact with many cases where certain employees on the work at which they are employed could make but 60 per cent efficiency. After three or four shifts had been made to different operations, the worker was finally assigned to some operation on which he could reach from 160 to 180 per cent efficiency simply because he had ideal mental and physical qualifications for the operation selected.

Due to the flexibility of these bonus systems a far greater percentage of the workers can be placed on a reward basis than under piece work or many other plans. Practically all employees engaged in and about plants can be placed on some form of reward in proportion to their efforts expended.

WASTE ELIMINATION BONUS

In general, as production is increased the tendency is towards a decrease in quality. To overcome this, one of the strongest features is the introduction of a waste elimination bonus. These are based on identical principles as those of the production bonus; that is, a standard quality or amount of waste is set and as the quality is increased above this standard or waste decreased below this standard an extra bonus is paid. Also a very thorough training and inspection system helps greatly to increase quality. The writer has found in general that where the installation has been carefully made, quality is increased rather than diminished and in many instances there have been enormous savings in waste elimination alone.

THE DESIGN OF BONUS SYSTEMS TO MEET CERTAIN CONDITIONS

By keeping well in mind the objects to be attained and the fundamental principles involved, equitable bonus systems can be designed to meet almost any conditions.

Recently the manager of a large and prominent plant was face to face with a very serious labor problem. This plant was in a very much better condition than most plants of its kind. This executive had a far greater knowledge of the principles and practices of scientific management than the average executive. It was absolutely essential that production be considerably increased. Due to the extreme scarcity of labor the best possible method for increasing the production was by increasing the effectiveness of the present labor forces. It was realized that the strongest possible method would be the introduction of some incentive form of wage payment. The entire plant had

been on a day work basis since its conception. The attitude of the employees had always been strongly against anything but day work and the chief problem was to submit to them some form of wage payment plan which would be acceptable to them and to which they would give their full and hearty co-operation. After a thorough study of the conditions, in all their various phases, the writer designed and introduced a bonus system which met with the hearty approval of the employees. As a result, the average production of such operations on which the method has been applied to date has increased approximately 65 per cent. The average wage to employees under the bonus plan has been increased from 25 to 30 per cent. The object has been attained. The management profited by the tremendous increase in production and the decrease in labor costs and the employees by a considerable increase in their earnings.

Actual practice has shown that the differential time bonus system is far superior to piece work. A certain plant had been on piece work for years. On analyzing the operations it was found that the evil of limitation of output existed. The piece work system was replaced by a differential time bonus system and a very marked increase in production was effected throughout this plant.

DETERMINATION OF STANDARDS

The success of any payment plan of this kind rests upon the accuracy and equitableness of the standard times. By applying modern methods of motion and time study and a thorough study of the fatigue problem equitable standards can be set. Such standards, however, should not be set by untrained persons but under the guidance of experts, thoroughly familiar with analysis, fatigue, and such economic, psychological and sociological factors as have a bearing on the attitude of labor.

WORKING HOURS

In most industries, the tendency now appears to be toward the eight-hour day. Statements have been made at various times that the same output could be obtained by reducing from a ten-hour to an eight-hour basis. These statements may have been true in certain cases, but in general this is not the case. Any given plant, however, operating under a ten-hour basis under day work or a wrong wage payment plan can be made to produce as much, and even more, in eight hours than in ten hours by a more thorough analysis and standardization of operations, better training of workers, improved scheduling methods, and the introduction of the best possible type of bonus system.

In many industrial districts, especially in such plants working on war supply contracts, the eight-hour day is in effect, but in the majority of cases the workers actually are employed ten hours and receive time and one-half for overtime over eight hours. This appears to be the popular trend today.

THE DILUTION OF MALE LABOR WITH FEMALE LABOR

Owing to the great scarcity of labor it has become absolutely essential to employ women in industry. In order to be successful in this undertaking, far better methods of all kinds must be applied. The problem of intensive training and supervision becomes greater.

There are numerous operations in almost every plant which can be performed by women and by proper selection, training, and supervision and by improving working conditions, in the course of time the outputs on such operations will be just as great, if not greater, than under former male labor.

CONCLUSION

In conclusion, it must be stated that even the best and most approved wage payment plan is not a cure for all ailments. It is absolutely essential, and a patriotic duty to every industrial organization to see that the greatest possible production with the least waste and cost is obtained. An ideal bonus system may have no effect whatsoever, or a disastrous effect, in case it is wrongly applied. Owing to the tremendous importance of the problem and the effect of such methods, it is the duty of every executive contemplating the introduction of such plans to see that:

- (A) The design of the method is absolutely correct and does not violate fundamental principles.
- (B) That the plan be correctly introduced.

Where this is done the objects will be attained and the results will be to the ultimate benefit of both employer and employee, which is the acid test of any method or plan.

Chicago, Ill.

Foreign Trade Convention Postponed.—The Executive Committee of the National Foreign Trade Council announces that "owing to the railroad congestion and the desire of the council to co-operate with the Government in the relief of the situation due to the war," the dates of the Fifth National Foreign Trade Convention to be held at Cincinnati, Ohio, have been changed from Feb. 7, 8 and 9 to April 18, 19 and 20, 1918. Merchants and manufacturers who are desirous of receiving invitations to attend the convention at Cincinnati are requested to send their names and addresses to O. K. Davis, Secretary National Foreign Trade Council, 1 Hanover Square, New York City.

Tariff Committee of Dyestuffs Association.—The Committee on Organization has appointed the following Tariff Committee: Dr. J. Merritt Matthews, chairman; August Merz of Heller & Merz; R. T. Dicks of Dicks, David & Co., and H. G. McKerrow of E. F. Drew & Co., all of New York; L. A. Ault of Ault & Wiborg Company of Cincinnati, and C. S. Althouse of the Althouse Chemical Company of Reading, Pa. The committee held a meeting on Feb. 11, at which the final proposals to be submitted to the Tariff Commission were gone over. It will hold another session in Washington immediately before conferring with the Commission. This committee has formulated definite ideas as to what the tariff regulations should be in order to safeguard the industry and has also determined upon what is considered a just and fair schedule of tariff rates. These are being withheld for the present by the committee, pending two conferences which that body has arranged to hold with the United States Tariff Commission in Washington.

It is expected that this committee's report will be in such shape that it may be included in the report of the main committee to the meeting of the main body of the newly organized association on March 6 at the Chemists' Club in this city.

The Vulcanization of Rubber

By ANDREW H. KING

THE whole structure of rubber products rests upon one important discovery—vulcanization. In 1839 Goodyear of New Haven, Conn., found that rubber, when mixed with sulphur and heated, underwent a "change." That is, that its physical properties were decidedly altered. It now had a much greater stability toward temperature changes, and showed a large increase in tensile strength and elasticity. This was the principal and basic discovery, and is used in nearly all the rubber shops the world over. The cold process of vulcanization by the use of a dilute solution of sulphur chloride, S_2Cl_2 , was developed by Alexander Parkes in 1846. There is no question as to the relative importance of the two discoveries. The cold process finds application only with extremely thin pieces of rubber, such as toy balloons, etc., and some kinds of spread goods.

Regardless of the manner in which it comes about, vulcanization is similar to the hardening or coagulation of a gel. A typical example of such a change is the behavior of glue with tannin. It requires no great stretch of the imagination to compare it with the setting of a custard pie or the baking of a fruit cake. The fruit cake idea is of particular value in that it gives us a simple homely parallel which will serve to make the mystery of compounding and vulcanization a little more understandable.

In preparing a cake the first concern of the cook is to produce a colloidal suspension, a batter consisting of milk, flour and eggs. To this are added the sugar, fruit, flavoring, baking powder, etc. When completed it is in the form of a not too stiff dough. It is then poured into pans and baked. The heat sets or coagulates the gel. That it happens also to liberate a gas which brings about porosity does not alter the similarity. In fact, in preparing sponge rubber the rubber chemist also resorts to this trick. The pastry cook must understand the preparation of the gel. He must know how to produce the properties of taste, flavor, etc., which make a cake so desirable to mankind. Compounding is not greatly different. It is the art of mixing various materials with rubber which give to it, subsequent to vulcanization, certain desirable physical properties.

The first step in the preparation of a stock is to break down the rubber. This is accomplished on a mill which consists essentially of two large horizontal rolls which rotate toward one another. To break down the rubber is, as is implied, to render it soft and plastic like a dough. When this condition is reached the various compounding ingredients are added. The plastic rubber takes them up in much the same way as bread dough takes up more flour. The rubber behaves as a super-cooled liquid and a stock is no more nor less than a solid solution. That the solid fillers are not added in lumps like chopped fruit to a cake but in very fine powders is due only to the fact that more desirable physical properties are obtained thereby. The unvulcanized stock is a highly plastic mass with but very

little elasticity or strength. Vulcanization reverses the situation, after which we find it strong and elastic with but very little of the original plasticity remaining. The effect of the individual fillers will be discussed in a later paper, but it will suffice here to say that their general effect is to decrease the stretch and to increase the tensile strength, hardness, toughness, and resistance of the stock to wear. This effect is not in direct proportion to the volumes involved, for some fillers give a greater increase and some a less. For example, if equal volumes of gas black and barytes be added to rubber in two separate but otherwise similar batches, the one containing the black will show a higher tensile strength and a relatively lower stretch, while that containing the barytes will show a lower strength and a higher stretch. This difference in behavior may be due to a number of things but is thought to be fundamentally a phenomenon of adsorption.

The above gives a general idea of the usefulness of vulcanization. We will now go on the various theories which have been advanced from time to time, as explanations of the mechanism by which it occurs. These theories are all of them incomplete and imperfect. But poor as they are they afford us a vehicle of thought and their proof or disproof advances our knowledge of the subject.

CHEMICAL THEORY

Carl Otto Weber was the first to investigate the chemistry of vulcanization. He divided the sulphur of a mixing, subsequent to heating, into two classes—free and combined. The first was removable by solvents, acetone being most satisfactory. The second, combined sulphur, he was never able to eliminate. In fact, no one with the possible exception of Spence, has ever been able to do it either. He found that rubber containing less than 2 to 2½ per cent combined sulphur did not show completely the physical characteristics of a properly vulcanized stock. First evidence of the "change" is seen when the combined sulphur is about 1.25 per cent. The physical properties become better and better until 2 to 2½ per cent combined sulphur is reached. He therefore concluded that this amount of combined sulphur was necessary to produce the first of a series of compounds which he called polyprene sulphides, the empirical formula of which he thought to be $(C_{10}H_{16})_{10}S$ which indicates 2.3 per cent combined sulphur. By using larger amounts of sulphur and a longer period of heating he obtained, just as did Goodyear before him, a hard substance, an ebonite, which contained approximately 32 per cent of combined sulphur. Try as he might he was unable to produce an ebonite with more than this amount of combined sulphur. This would indicate a compound of the formula $C_{10}H_{16}S_2$, or better $C_{100}H_{160}S_{20}$, which he concluded to be the highest member of his series of polyprene sulphides. As evidence which would tend to prove the existence of the intermediate members of the series, he recorded that the relation of combined sulphur to time, tempera-

ture being held constant, was not a linear function but that certain breaks were noticeable in the curve. Each break he thought indicated a new polyprene sulphide. Axelrod thought somewhat differently of the matter. He considered, and rightly, that heat has two effects on rubber, first to make it soft, plastic and tacky, to depolymerize it; and second to bring about the combination with sulphur. The breaks in the curve he concluded showed depolymerization, followed by further addition of sulphur. He did not seek to overthrow Weber's theory but only to supplement it. Now it happened that Weber heated mixtures of sulphur and rubber (9.1 per cent sulphur) in an autoclave at fixed temperatures between 120 deg. C. and 130 deg. C. Samples were withdrawn every hour or half hour and their combined sulphur determined. It is not surprising in view of such faulty technique that the curve contained several sharp bends. Every time the autoclave was opened to remove one piece the other pieces were undoubtedly cooled off. No one has ever isolated these intermediate polyprene sulphides, which fact gave Wolfgang Ostwald a point in favor of the adsorption theory. The investigation was at a standstill for a number of years until Spence, seeking to prove the adsorption theory, heated different samples of a mixture of rubber with 37 per cent sulphur for varying lengths of time. His combined sulphur curve showed a regular increase with time from zero up to 31.97 per cent. There were no breaks nor bends in his curve whatever. He did show, however, that the removal of the free sulphur gave typical adsorption phenomena and concluded that the first step of vulcanization is adsorption of the sulphur, after which a part of it becomes chemically combined.

The evidence in favor of the chemical theory may be summarized as follows:

1. There is no process by which the combined sulphur can be removed and the original rubber regenerated. Reclaiming processes remove only the free sulphur.

A possible exception to this statement may be found in a late patent to Spence (U. S. 1,235,850) in which he claims to actually devulcanize rubber. After the removal of the free sulphur the combined sulphur is eliminated by heating in an aniline solution of metallic potassium or sodium for several hours at 175° C. The solution is filtered, the aniline distilled off and the rubber dissolved in benzol, when it is purified by treatment with water containing hydrochloric acid. Piperidine, caustic soda, and para aminodimethyl aniline, all powerful vulcanization accelerators, are recommended to assist and to speed up the devulcanization. Seventy-three per cent of the combined sulphur in ebonite was removed in one operation. The principle of the process is simple. Spence reasoned that all that was necessary was a powerful vulcanization accelerator in conjunction with an element capable of combining with and fixing the sulphur liberated from the rubber by the accelerator. The more powerful the accelerator the more rapid would be the devulcanization. It is to be sincerely hoped that Spence will be entirely successful in his experiments, and that their commercial application will not be long delayed. A reclaiming process which will truly devulcanize rubber is sorely needed. But should this process be successful it will not in the least invalidate the

chemical theory, but will rather strengthen it, showing merely that another reaction takes place during which another substance combines with and removes the sulphur from the rubber. That such substances are powerful accelerators throws considerable light on the mechanism of acceleration, which will be discussed later.

2. Alexander showed that there was a definite stoichiometric relation between the maximum quantities of sulphur and bromine which may be added on. For instance, the maximum quantity of bromine which may be added is equivalent to 32 per cent of sulphur. Also, if 16 per cent of sulphur is already combined with the rubber the maximum amount of bromine which may be added is equivalent to 16 per cent of sulphur. Ebonite with 32 per cent combined sulphur cannot add on any bromine. You will note that we are here speaking of addition in the sense that it is known to the organic chemist and which differs considerably from substitution. The addition of bromine to rubber is considered by most chemists as taking place at the double bonds. It is not unreasonable then that sulphur should combine in the same way.

3. Vulcanization is subject to conditions like any other chemical reaction. Increased temperature accelerates it. The mass action effect of sulphur is marked and the catalytic behavior of certain substances is well known.

4. The work of Hinrichsen has shown that cold vulcanization by means of sulphur chloride is a true chemical reaction. The maximum quantity of sulphur chloride which may be added is about 33 per cent S_2Cl_2 , which would indicate a compound $(C_{10}H_{16})_2S_2Cl_2$.

Vulcanization, according to the chemical theory, must be due to the chemical combination of sulphur with rubber, which combination probably takes place at the double bonds and is an addition and not a substitution. The existence of but one polyprene sulphide has been definitely established, namely, ebonite $(C_{10}H_{16})S_x$.

ADSORPTION THEORY

This theory was advanced by Wolfgang Ostwald some years ago. He considered vulcanization to be simply a case of physico-chemical adsorption. The main points in support of his theory are:

1. Some free sulphur always remains after vulcanization. This fact Ostwald considers an evidence of adsorption on the ground that if vulcanization were a chemical reaction there should be certain conditions under which no free sulphur would remain. It is axiomatic that for any chemical reaction to go to completion the product of the reaction should be removed as fast as formed. This is obviously impossible in this case. The colloidal nature of rubber also tends to retard the reaction and prevents its completion.

2. Ostwald based another claim on the bends in Weber's curve. He pointed out that the different polyprene sulphides had never been isolated and that their existence might be explained equally well by the adsorption theory. In view of Spence's work the question requires no further comment.

3. Sulphur may be removed by suitable solvents on long treatment. This statement has been disproved many times. Spence has shown that the free sulphur

may be removed and that it is truly adsorbed. Combined sulphur is insoluble.

4. Figuring from Weber's data Ostwald obtained 1.87 for the temperature coefficient. Van't Hoff calculated that for a chemical reaction between rubber and sulphur a coefficient of 2 to 3.5 would be required. Adsorption gives a coefficient of 1.36 and while 1.87 is certainly nearer to 2 than 1.36, yet Ostwald held this to be in favor of his theory. The temperature coefficient based on Spence's work is 2.65.

5. Stern dissolved rubber and sulphur in fused naphthalene. His results were not satisfactory but he concluded that they were more in accord with the adsorption theory than with the chemical theory. It might be observed that rubber when dissolved in any solvent and heated, becomes rapidly depolymerized and if the operation is continued for any length of time it loses its normal properties and becomes more and more like the terpenes.

There is to date no evidence that a chemical reaction does not take place and the adsorption theory, as a theory to stand alone, has been definitely disproved.

OSTROMYSLENSKI'S THEORY

This theory came about through a study of the addition products of rubber with various aromatic compounds. Ostromyslenski found that substances which ordinarily form addition products such as picric acid, picryl chloride, triphenyl methane, etc., did not produce vulcanization but that compounds rich in oxygen such as nitro-compounds capable of giving up some of it did produce the "change." This led him to try benzoyl peroxide which readily yields oxygen, and it also vulcanized. He obtained best results with 1:3:5 trinitrobenzol and benzoyl peroxide, $C_6H_3(NO_2)_3-CO-O-CO-C_6H_5$. Physical tests on rubbers vulcanized according to his directions were made by Stevens' and are given in Tables I and II. The value of his work has been questioned on the ground that his "vulcanized" products were inferior to rubber vulcanized by sulphur. This is true, all but benzoyl peroxide and trinitrobenzol give hopelessly low results, and these while better than the rest, do not produce a vulcanized product equal to that of sulphur. However, he did obtain the "change" and his products were in most cases superior to the original crude rubber.

Because of the fact that substances with such widely different chemical and physical properties as the peroxides, nitro-compounds, sulphur and sulphur chloride, all produce vulcanization it is probable that vulcanized rubber as we know it is not the product of a simple chemical reaction, but that the vulcanizing substance first acts chemically on a small portion of the rubber forming a derivative which is in turn adsorbed by the unchanged rubber.

He further supported his theory by obtaining vulcanized products with rubber bromide and hydrochloride.

His theory is then, that only on polyprene sulphide, $C_{10}H_{16}S_2$, is formed, and that this substance being adsorbed on the remaining rubber gives it the properties which lead us to call it vulcanized. Thus he combined both the chemical and adsorption theories. No one has yet, to my knowledge, produced vulcanized rubber by heating caoutchouc with polyprene sulphide. This may

TABLE I

Vulcanizing agent	1:3:5 Trinitrobenzol										Trinitro- Benzol and Sulphur
Parts same	4	4	1	1	4	4	1	1	4	10	10
Other ingredients					Li- tharge	PbO	PbO	MgO	MgO		
Parts same					30	30	30	30	30		
Cure, min. @ 140° C.	5	10	60	90	5	60	60	75	40	90	90
Color vulc. rubber	Black	Black	Brown	Brown							
Breaking load (gm./sq. mm.)	954	876	376	318	226	104	419	359	1067	1590	1223
Final length	8.56	7.80	8.69	8.56	5.15	2.74	7.3	7.13	5.42	9.36	9.7
Tensile product	82	68	33	27	12	3	31	26	58	149	119
Acetone extract, %	2.12	2.20	148	105	2.16	2.22	2.11		1.58		
Nitrogen in same (calc. on rubber)	.24	.10	.04	.06							

TABLE II

Vulcanizing agent	Dinitrobenzol		Benzoyl Peroxide					
Parts same	4	4	.33%	.33%	1.33%	1.33%	6.69%	6.67%
Cure, min. @ 140° C.	90	120						
Cure, min. @ 130° C.			60	30	60	30	15	10
Color vulc. rubber	Black	Black						
Breaking load (gm./sq. mm.)	56	53	34	29	35	57	412	389
Final length (orig. 100)	5.36	5.60	228	181	219	339	1025	1006
Tensile product	3	3	8	5	8	19	42	39
Acetone ext., %	1.36		1.17	3.04	2.00	2.01	2.18	381
Nitrogen in same (calc. on rubber)	.06	.06						

not be an objection because of the difficulties of obtaining $C_{10}H_{16}S_2$ in a condition in which it may be readily adsorbed. Before the theory can be accepted some one must find a solvent for or a method by which polyprene sulphide may be separated from the unchanged rubber. Should this be done, and it may be accomplished, it would not be the first time that the product of a chemical reaction adsorbed on the unchanged substance in varying amounts, gave rise to a belief in a whole series of compounds where only two actually existed. A classic example of this statement is found in the confusion in the past regarding the oxy-celluloses.

ERDMANN'S THEORY

The friends of both the chemical and Ostromyslenski theories consider that a true chemical reaction takes place between rubber and sulphur. The Erdmann theory is of importance because it seeks to explain the mechanism of this reaction. At 160° C., which is practically the upper limit of vulcanizing temperatures, molten sulphur contains a large portion of thiozone molecules, S-S-S. It is considered that thiozone acts on rubber in the same manner as ozone producing a thiozonide of caoutchouc.

The theory is of particular interest in that it gives us a partial explanation of the behavior of organic accelerators. Ostromyslenski has produced some evidence that these catalysts are substances which are capable of forming thiozonides with sulphur. If this is true it is quite probable that vulcanization proceeds in the following consecutive steps:

1. The union of the accelerator with sulphur forming a thiozonide. No accelerator has yet been found which does not contain nitrogen. The junction likely occurs between the nitrogen and sulphur atoms.

2. The addition of the thiozonide to the rubber molecule.

3. The splitting off of the accelerator, leaving the sulphur attached to the rubber. We cannot be sure that this splitting off always occurs. In fact, there is an indication in the peculiar snap and altered physical properties of stocks vulcanized by the aid of hexamethylenetetramine, which makes it seem probable that the thiozonide of this accelerator does not split off the catalyst after combining with the rubber.

The point has been raised by Eaton that accelerators are not true catalyzers because they do not remain unchanged throughout the reaction. It is quite true, so far as we know, that no accelerator remains absolutely unchanged during vulcanization. But there is yet no evidence which would tend to indicate that the accelerator is not split off from the rubber in the unchanged condition and that the decomposition is not brought about by side reactions. For example, the odor of phenyl mustard oil is always noticeable about a thiocarbanilide stock when it is freshly removed from the vulcanizing press. Thiocarbanilide when heated under several conditions sets free phenyl mustard oil. There is no evidence to show that the decomposition of thiocarbanilide producing phenyl mustard oil during vulcanization is not a secondary reaction. Phenyl mustard oil $C_6H_5N=C=S$ has comparatively little accelerating value.

RELATION BETWEEN COEFFICIENT OF VULCANIZATION AND PHYSICAL PROPERTIES.

This subject is one which has aroused rather severe controversies across the water during the past couple of years. In fact it is as yet unsettled. The term coefficient of vulcanization was introduced by Weber and means simply the percentage of combined sulphur based on the rubber. It is admitted by all concerned that a correctly vulcanized rubber gives more general satisfaction than one which has not the correct degree of cure. The point at issue is, What is the correct cure and how may it be recognized? The coefficient of vulcanization is certainly indicative but its use is restricted because very few rubbers are polymerized to the same degree. It is also limited by the difficulties surrounding a correct determination of combined sulphur since the universal method is to extract the free sulphur and determine the combined sulphur by difference. There is no method for determining the combined sulphur directly. The free sulphur, as has been already pointed out, is adsorbed. Its complete extraction within reasonable time is impossible. Consequently purity of solvent, kind of solvent, dimensions of extractor, time of extraction, condition of the rubber, etc., must all be rigidly defined before chemists may use the coefficient as a basis. After its determination is reduced to a working basis it is still of questionable value unless sulphides are determined. We look on rubber as having the empirical formula $(C_{10}H_8)_n$, n being a variable. When it is low, as is the case for rubbers of low natural polymerization or for those which have been overworked on the mills, more sulphur combines on vulcanization than is the case for rubbers of high natural polymerization, as for example, fine Para. In other words, the coefficient of vulcanization is higher in the first mentioned cases. I do not wish to leave the impression that good rubber may be overworked on the mills and by the simple expedient of adding on more sulphur attain the properties of a correctly milled stock. Overmilling is always detrimental.

De Vries³ has put the proposition well:

"From my experiments it is clear that the reaction between sulphur and rubber and the changes in the rubber-sulphur mixture which determine the mechanical properties as expressed in the stress-strain curve are two different processes which proceed independently of

one another and that speaking in general it is not feasible to make deductions from one regarding the other."

The compounder has only a passive interest in the coefficient of vulcanization. He is entirely wrapped up in the physical properties of his stocks. The coefficient may be 2 or 6 provided his compound meets specifications. He realizes, of course, that he must always obtain the correct cure but he prefers to judge this point from the physical properties rather than by the coefficient of vulcanization. He bases his judgment on such considerations as tensile strength, stretch, set, the characteristics of the stress-strain curve, and on an indefinite something which he calls "feel" but which is really the summarization of his experience with the particular type of stock in question.

PRODUCTION AND RATE OF CURE.

Vulcanization is essentially a chemical reaction. This statement is one in which every rubber chemist will concur. The rate of cure is susceptible to the same influences as effect the speed of a chemical reaction. The most important considerations are:

1. Mass action.
2. Catalysis.
3. Temperature.

MASS ACTION

As would be expected, an increase in sulphur content decreases time required for vulcanization. The mass action effect has been investigated by Skellon.⁴ He reports the following figures:

Time of Cure	ADDED SULPHUR					
	3%	5%	10%	20%	30%	40%
	COMBINED SULPHUR					
	3%	5%	10%	20%	30%	40%
30 min. @ 140° C.....	.36	.44	.63	.59	.55	.51
1 hr. @ 140° C.....	.46	.63	1.07	1.05	.95	.83
1 hr. 30 min. @ 140° C.....	.70	1.02	1.65	1.64	1.47	1.32
3 hrs. @ 140° C.....	1.42	2.06	3.35	4.07	3.58	3.13
6 hrs. @ 140° C.....	2.88	6.18	11.33	11.62	10.93	10.22
9 hrs. @ 140° C.....	8.76	17.32	24.10	25.5	25.0

CATALYSIS

Whether we choose to call it catalysis or acceleration, its effects are to be seen in the behavior of every mix on vulcanizing. Some substances speed up the reaction while others retard it. The chief retarders or negative accelerators are:

1. Alkali in excess of 3 per cent.
2. Acids.
3. Molybdenum sesquioxide over 10 per cent.
4. Nickel oxide.
5. Phenylhydrazine.
6. Glucose.
7. Methylene blue.
8. Most oils and greases.
9. Asphaltic products.

Some of these are not true negative catalyzers but mere sulphur removers in that they react with sulphur as easily or easier than rubber.

In a previous paper⁴ the writer gave a partial review of the organic accelerators. To this list may now be added:

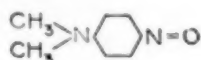
³Rubber Industry, 1914.

⁴This Journal, Sept. 1, 1916, p. 231.

²I. R. J., Jan. 20, 1917, p. 17.

1. Para Nitroso-Dimethyl Aniline.

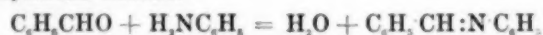
Nitroso derivatives of methyl aniline, dimethyl aniline, ethyl aniline and diphenylamine are powerful accelerators.⁶ P-Nitroso-dimethyl aniline, sold under the trade name of accellerene, is the best. It is a green crystalline powder melting at 85 deg. Cent. and is produced by the action of nitrous acid on dimethyl aniline. The structural formula is



Peachy states that the addition of .3 to .5 parts accellerene to a mix of 100 parts rubber, 10 parts sulphur, cuts the time from 1 hour at 140 deg. Cent. to 20 to 25 min. at the same temperature. This mix probably contained, though not stated, some mineral accelerator such as lime or magnesia. With hard rubber the addition of 0.75 per cent accellerene to a mix of 100 parts rubber, 40 parts sulphur cuts the time from 6 hr. at 140 deg. Cent. to 2 hr. In general the addition of .3 to .5 parts of P-Nitroso-dimethyl aniline to high quality stocks cuts the time to 1/3 or 1/4 that formerly required. It cannot be used with antimony sulphide, litharge, or shoddy. The addition of magnesia is a decided help.

2. Condensations between aldehydes and amines.

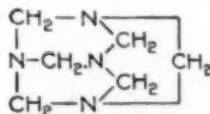
Type reaction: Benzaldehyde with aniline forming benzylidene aniline.



This is an active accelerator but less so than P-Nitroso-dimethyl aniline.

3. Hexamethylene tetramine:

This substance $(\text{CH}_2)_6\text{N}_4$ is produced by the action of ammonia on formaldehyde at ordinary temperatures. It is a crystalline basic substance having the structural formula:



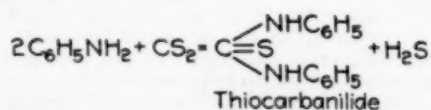
This accelerator must not be used in conjunction with litharge, magnesia, or lime. About the only metallic oxide with which it is not incompatible is zinc oxide. It is about twice as powerful as thiocarbanilide, and must be used in rather small amounts. It gives a stock a peculiar snap and stiffness unlike any other accelerator known.

4. Piperidine-piperidyl-dithio-carbaminate:

This accelerator is by far the most powerful of all those known to-day. First mention of it was made by Ostromyslenski.⁷ It is formed by the action of carbon bisulphide on piperidine.



The reaction is similar to that producing thiocarbanilide from aniline and carbon bisulphide except that no hydrogen sulphide is evolved.



The addition of .5 to 1 per cent in conjunction with 5 per cent magnesia or litharge diminishes the time required for vulcanization to 1/40th of the original

time. In the presence of 2 to 5 per cent of the accelerator, vulcanization of either synthetic or natural rubber is complete in a few seconds at 130 deg. Cent. Stocks containing it to the extent of 2 per cent will become fully vulcanized on standing at room temperature for a month. Unfortunately it is far too powerful and too expensive for factory practice.

Accelerators in more ways than one are similar to explosives. Properly used they are a boon, but used without discretion they can produce more havoc on a firm's balance sheet than anything I know of. To get results one must have long experience with them and must take nothing for granted. In general, a combination with one or more of the metallic oxides works well, but this must be very carefully studied before final decision.

TEMPERATURE

As stated previously, vulcanization is essentially a chemical reaction brought about by heat. In common with such reactions the application of a higher temperature brings it to completion in a shorter time. It was formerly held that high temperatures were harmful, and so they are when the nature of the article is such that heat flow is very slow, but whenever the piece can be brought to press temperature through and through in a very short time, a higher temperature for a shorter time produces a better article than a lower one for a longer time. The subject has been investigated by Kratz,⁸ who reports the following figures on a stock made up of 100 parts first latex crepe, 100 parts zinc oxide, and 5 parts sulfur.

Time, Min.	Steam Pressure, Lb./Sq. In.	Temperature, °F.	Tensile Strength, Lb./Sq. In.	Stretch, per Cent	Tensile Product
120	36	282	2896	750	217
90	43	290	2747	725	200
60	50	298	2755	725	200
43	55	303	3064	725	222
30	60	307	2947	775	229
22	65	312	2854	800	228
18	70	316	2563	750	193
14	75	320	2656	725	192
11	80	324	2545	750	191
8	85	328	2970	800	238

The relation between temperature and rate of vulcanization has been investigated by Bourn,⁹ who has summarized his experiments in the following statements:

1. The velocity of the combination increases faster than the increase of temperature, and decreases correspondingly with a decrease of temperature.

2. For every increase in temperature of about 11 deg. Fahr. the velocity is doubled, and for each decrease in temperature of about 11 deg. Fahr. the time required is doubled.

3. Above 304 deg. Fahr., when the constitution of sulfur changes, the velocity doubles in approximately 25 deg. Fahr. instead of 11 deg. Fahr.

PRODUCTION.

The novice might imagine that if one can use accelerators and reduce the time required for vulcanization from 1 hr. to 25 min. that the desirable thing to do would be to put in more accelerators and pull the time down to 5 min. or to zero time for that matter. That line of reasoning would be correct provided no condi-

⁶British Pat. 4263, 1914. Peachy, I. R. J., May 12 and 19, 1917.
⁷J. Russ. Phys. Chem. Soc., 47, 1441-53, 1915. Chem. Abst., 1916, p. 3176.

⁸I. R. J., 1916, p. 661.

⁹Rubber Industry, 1914.

tions other than production had to be met. Unfortunately there are other factors to consider. Chief of these are:

1. Stages in factory process.
2. Heat conductivity.
3. Stocks in contact.

STAGES IN FACTORY PROCESS

These include milling, calendering, tubing, etc., regular factory operations during which there must be no scorching. By scorching I mean the partial vulcanization brought about by overheating. This tends to give lumpy stocks unsuitable for further operations. A stock must not be too heat-sensitive.

HEAT CONDUCTIVITY

Rubber is not a good conductor of heat. Small articles, such as the average piece of molded goods, heat up quickly, but large bulky articles require an appreciable time for the heat to penetrate into the interior. Built-up articles such as hose, belting, etc., containing cotton duck do not permit a rapid flow of heat to the interior and must be cured at comparatively low steam pressure, 30 lb. or under; the idea being to prevent the outside layers from becoming over-vulcanized while the interior would be yet under-cured.

A low temperature requires a long period of heating and reduces production. The usual manner of circumventing this difficulty is to use a "rising cure." A typical example of such a cure is as follows:

20 min.	@	20 lb.	steam pressure
30 "	@	30 "	" "
40 "	@	40 "	" "

As the name implies, the heat is increased in successive steps which are made far enough apart to allow complete penetration and equalization before going on with the next step.

STOCKS IN CONTACT

Under this head we must consider not only such stocks as may be in actual contact but all the stocks which enter into the makeup of the article. For example, in the pneumatic tire we have different stocks for the tread, cover, cushion, breaker strip, sidewall and bead. The compounder must so adjust his stocks that all of them will reach the desired degree of vulcanization at the end of the period. Most beads are semi-hard rubbers and must be partly cured before being built into the tire. In general, stocks in contact should have the same rate of cure.

A New Source of Potash

Present Development and Future Possibilities of Extraction from Chile Nitrate

A SOURCE of potash which has not been seriously considered heretofore, and which has enormous possibilities, was described by C. M. Barton, vice-president of the du Pont Nitrate Company, at a recent meeting of the Delaware Section of the American Chemical Society in Wilmington. He stated that not only had the du Pont Company succeeded in producing potash in paying commercial quantities from the Chilean nitrate ores, but that it had given its processes to the representatives of companies from allied and neutral countries which operate plants in the nitrate fields of Chile.

The du Pont Company produces only about one per cent of the output of the Chilean nitrate fields, but it has succeeded, by its processes, in producing 10,000 tons a year of a product containing 25 per cent of potassium nitrate. This is equivalent to about 1200 tons of potassium oxide.

The others of the 200 nitrate plants in Chile are capable of producing an average quantity of potash equal to that produced by the du Pont Company. On this basis the production would be 240,000 tons a year, but the process can be further developed and improved. There is good reason to believe that in a short time it can be improved to such an extent that instead of recovering about one-third of the potash in the ore it may be possible to recover virtually all and thereby bring the total possible output up to 720,000 tons a year. This is almost as much as the entire pre-war consumption of potash in the United States.

Germany's sale of potash before the war to the entire world amounted only to about 900,000 tons a year.

Mr. Barton outlined the process during his talk and stated that this process had been in operation and had been improving constantly for a long while. He said:

"From the beginning of our operations we had known that our caliche at Oficina "Delaware" contained some potash and that our product contained on an average about 5 per cent of nitrate of potash. Working constantly on various theories for securing better yields and knowing that we could secure a desirable product for our refineries if we could get a nitrate containing a higher percentage of nitrate of potash, we found that by taking the mother liquor coming back from the crystallizing pans and evaporating it to a high density there was deposited from this upon cooling a product which contained on an average about 25 per cent of nitrate of potash. We had not found it a practical proposition to install evaporators for this purpose until in the latter part of the year 1914, when the price of muriate of potash started to climb up from \$35 per ton to a peak price of about \$500 per ton. In October, 1914, we produced our first H. P.—or high potash nitrate—and by securing further evaporators were able to increase our production of this, so that we have for a year or more secured about 25 per cent of our output in this form. We estimate roughly that up to October, 1917, we secured from this source at least 5000 tons of nitrate of potash, in the form of about 20,000 tons of our so-called 25 per cent H. P. nitrate.

"We erected three evaporators near the end of the maquina. The first was an old evaporator which had formed a part of the old Nordenflycht maquina, which was on the property when we bought it. The old maquina was torn down and parts of this old evaporator had been utilized for other purposes, but were reassembled, and it has been giving steady use. The other two evaporators we bought from another nitrate company that had received but never erected them, owing, we believe, to their having gotten 'cold feet' due to the trouble others had experienced through corrosion in evaporators when treating the liquors of the usual operations. We anticipated the corrosive effects, suffered from them, but a year ago were able to eliminate or at least minimize the corrosion very effectively by the addition to the liquor of a small amount of sodium carbonate.

"You can understand that this H. P. nitrate has proven very valuable to the du Pont Company, and we kept rather quiet about this portion of our operations until shortly after our entry into the war. It was then realized that the needs of the country were such that it was to the interest of the du Pont Company to surrender its position of vantage, and the representatives of the allied and neutral governments, whose subjects operate nitrate plants in Chile, were advised that the du Pont Company was willing to share with them its secrets in the production of this material."

The value of this process is emphasized by the fact that potash produced in Chile is a by-product of the nitrate industry, and hence can be produced very cheaply.

The Effect of Addition Agents in Flotation—III.

By M. H. THORNBERRY AND H. T. MANN

AS in the preceding discussion of the effect of addition agents in flotation, the results obtained by the addition of various chlorides are shown graphically in Charts 10, 11 and 12. The numerals on the charts are the numbers of the various experiments, three being made without any additions and four with each of the different agents. Those without addition agents are numbered 1, 2, 3 and 0, the last showing the average results of the first three. The numbers of experiments with addition agents are given in the following paragraphs, four to each experiment, and indicate results obtained respectively with 5, 15, 25 and 50 cc. of each agent.

To save repetition in the discussion of the results

we shall refer in this article to Cleveland Cliffs Iron Company's flotation oil No. 1, as "oil No. 1," and to General Naval Stores flotation oil No. 17, as "oil No. 17."

The reader should also bear in mind that when statements are made that a certain reagent raised or lowered the grade of concentrate or extraction, those results are compared with the results obtained when oil was used without any reagent.

CHLORIDES

ALKALI METAL CHLORIDES

NaCl. Nos. 8 to 11.—Sodium chloride when used with oil No. 1 had very little effect. The average extraction

was about 4 per cent lower, while the grade of concentrate was practically of the same grade as when no reagent was present. With oil No. 17 the extraction was lowered 9 per cent to 10 per cent, and the lead tenor of the concentrate was about 9 per cent lower. With cresylic acid the extraction was about 6 per cent lower and the con-

centrate about 5 per cent lower. When the results are taken as a whole, the quantity of sodium chloride used seemed to have very little effect on either the extraction or grade of concentrate produced.

KCl. Nos. 12 to 15.—Potassium chloride with oil No. 1 lowers the extraction about 5 per cent, but had practically no effect on the grade of concentrate produced. With oil No. 17 both the extraction and the grade of concentrate were lowered about 10 per cent. With cresylic acid the extraction and grade of concentrate were lowered about 5 per cent.

NH₄Cl. Nos. 16 to 19.—Ammonium chloride gives practically the same result as potassium chloride.

LiCl. Nos. 20 to 23.—The effect of lithium chloride is very similar to the effect of both potassium and ammonium chloride.

The alkali metal chlorides when compared, one with another, produce very similar results. There is apparently no relation between their individual chemical properties and their effects on either the extraction or the grade of concentrate produced. Their action with the various oils is very similar, varying only in degree. With oil No. 1 the extraction was lowered 4 per cent to 5 per cent and the grade of concentrate produced averages less than 1 per cent low. With oil No. 17 the extraction was lowered about 12 per cent and the grade

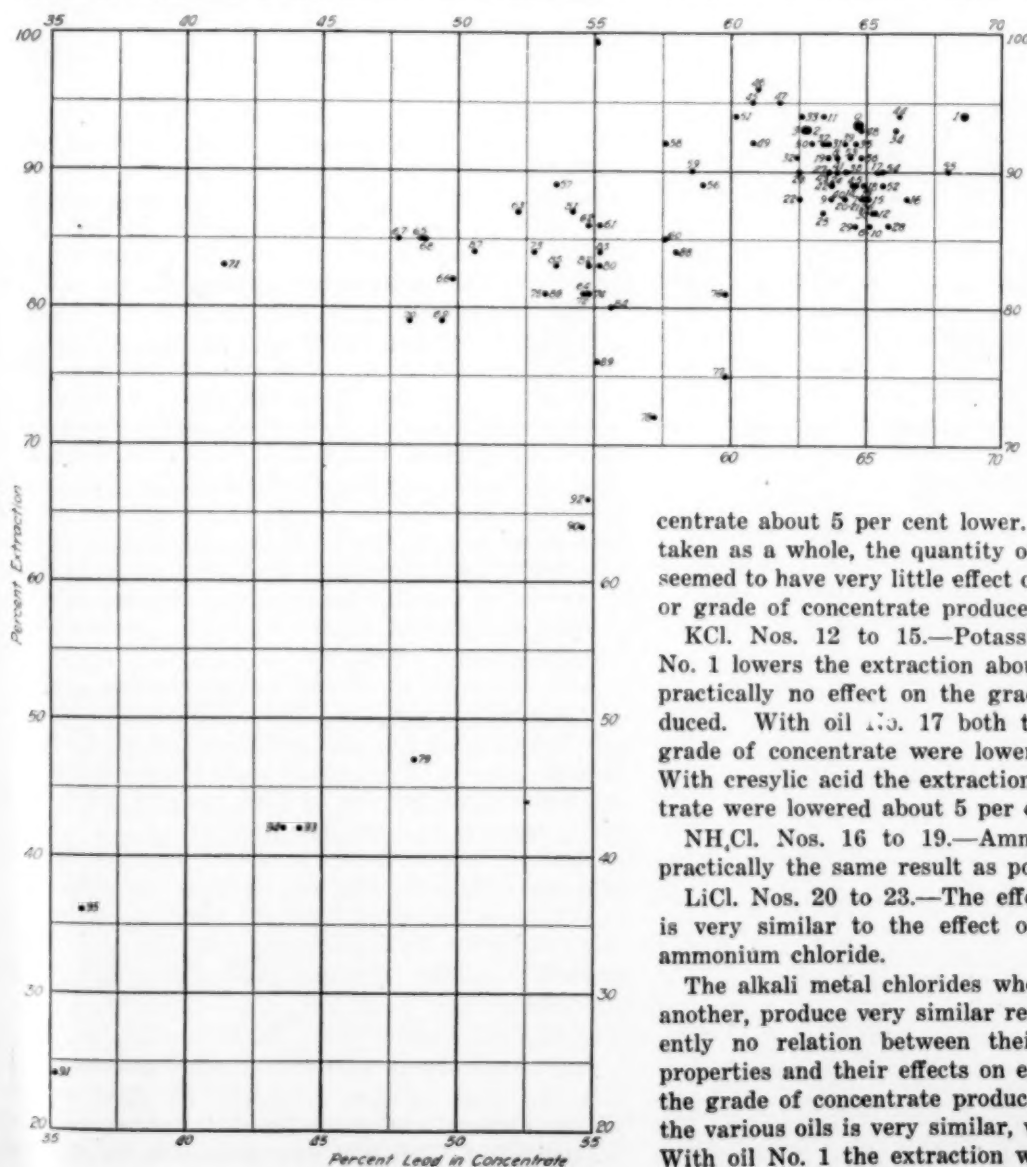


CHART 10. ADDITION AGENTS IN FLOTATION. EFFECT OF CHLORIDES ON THE FLOTATION OF GALENA WITH CLEVELAND CLIFFS IRON CO.'S OIL NO. 1

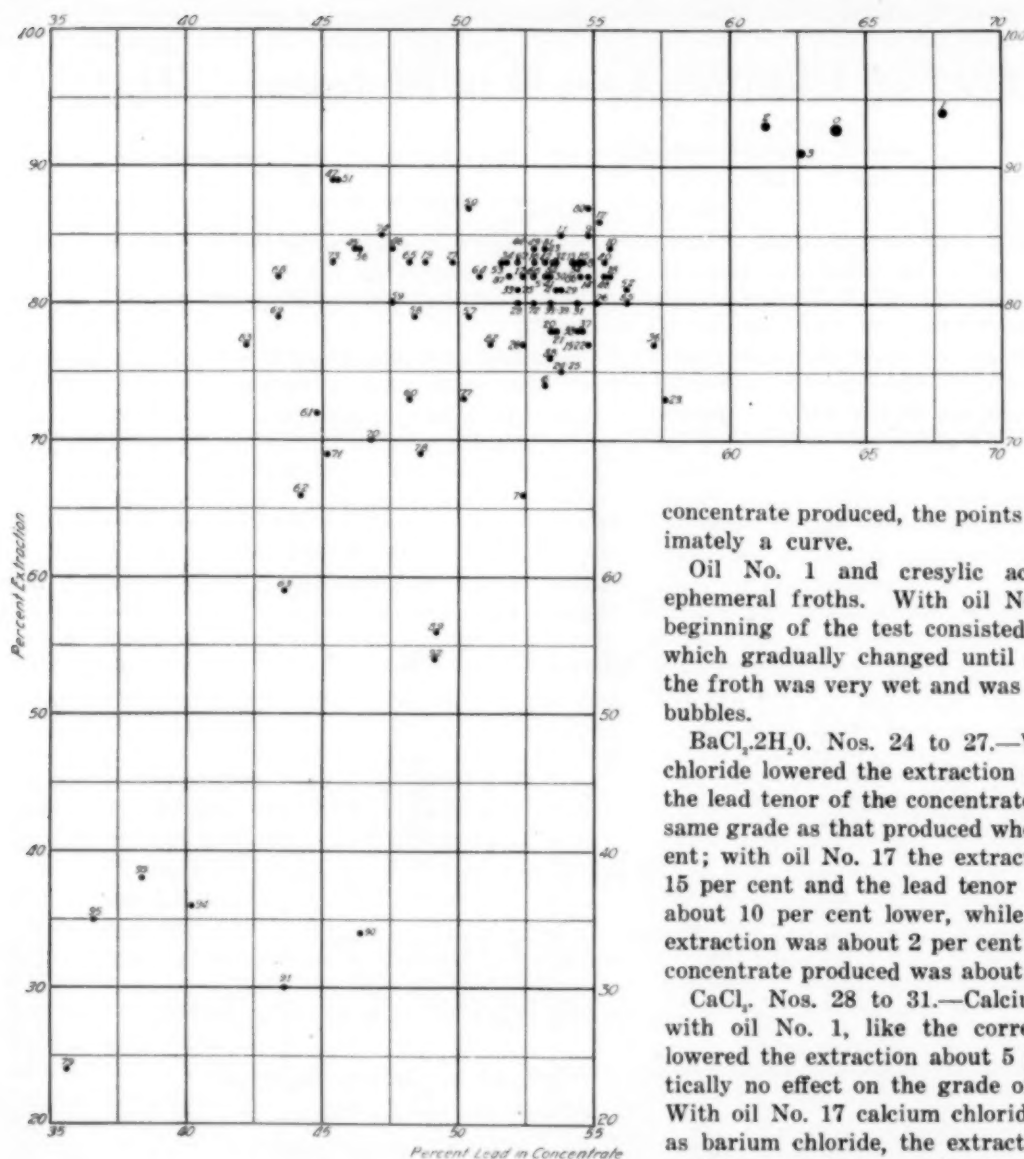


CHART 11. ADDITION AGENTS IN FLOTATION. EFFECT OF CHLORIDES ON THE FLOTATION OF GALENA WITH GENERAL NAVAL STORES FLOTATION OIL NO. 17

of concentrate was about 10 per cent low, while with cresylic acid both the extraction and the grade of concentrate were lowered about 5 per cent. The characteristic froth produced by these chlorides consists of large bubbles which break up quickly.

ALKALINE EARTH CHLORIDES

HCl. Nos. 4 to 7.—Hydrochloric acid when used with oil No. 1 lowered the extraction about 5 per cent, while it had practically no effect on the lead tenor of the concentrate. The quantity of hydrochloric acid apparently made little difference, either on the extraction or the grade of concentrate produced. With oil No. 17 the extraction was lowered about 10 per cent when 5 cc. of the reagent was used and 26 per cent when 50 cc. was used, the results falling roughly in a straight line. The grade of concentrate was lowered about 10 per cent in each test regardless of the amount of the reagent present. With cresylic acid and 5 cc. of hydrochloric acid the extraction was practically the same as when no

addition agent was present, but when 50 cc. was added the extraction was lowered about 13 per cent. The lead tenor of the concentrate varied from 4 per cent lower with 5 cc. to 7 per cent lower with 50 cc. With this oil, the greater the quantity of hydrochloric acid used the poorer the extraction and the lower the grade of

concentrate produced, the points plotted making approximately a curve.

Oil No. 1 and cresylic acid produced ordinary ephemeral froths. With oil No. 17 the froth at the beginning of the test consisted of large, dry bubbles, which gradually changed until at the last of the test the froth was very wet and was composed of very small bubbles.

BaCl₂·2H₂O. Nos. 24 to 27.—With oil No. 1 barium chloride lowered the extraction about 5 per cent, while the lead tenor of the concentrate was practically of the same grade as that produced when no reagent was present; with oil No. 17 the extraction was lowered about 15 per cent and the lead tenor of the concentrate was about 10 per cent lower, while with cresylic acid the extraction was about 2 per cent lower and the grade of concentrate produced was about 8 per cent lower.

CaCl₂. Nos. 28 to 31.—Calcium chloride when used with oil No. 1, like the corresponding barium salt, lowered the extraction about 5 per cent, but had practically no effect on the grade of concentrate produced. With oil No. 17 calcium chloride is not so detrimental as barium chloride, the extraction being about 12 per cent lower and the grade of concentrate about 10 per cent lower. With cresylic acid the extraction is about 3 per cent higher than the extraction obtained when no reagent was present, while the grade of concentrate is about 6 per cent lower.

SrCl₂. Nos. 32 to 35.—Strontium chloride with oil No. 1 has practically no effect. With oil No. 17 the effect was practically the same as that produced by calcium chloride. With cresylic acid the extraction was lowered about 6 per cent and the grade of concentrate was 7 per cent to 8 per cent lower.

MgCl₂·6H₂O. Nos. 36 to 39.—Magnesium chloride has practically the same effect as strontium chloride.

The results obtained with the alkaline earth chlorides and hydrochloric acid were very similar in every respect to those obtained with the alkali metal chlorides.

METALLIC CHLORIDES

MnCl₂. Nos. 40 to 43.—The quantity of manganese chloride seems to have practically no effect on the results obtained. With oil No. 1 the extraction was lowered about 4 per cent with practically no effect on the grade of concentrate produced; with oil No. 17 the extraction and the grade of concentrate were about 10 per cent lower, while with cresylic acid the extraction

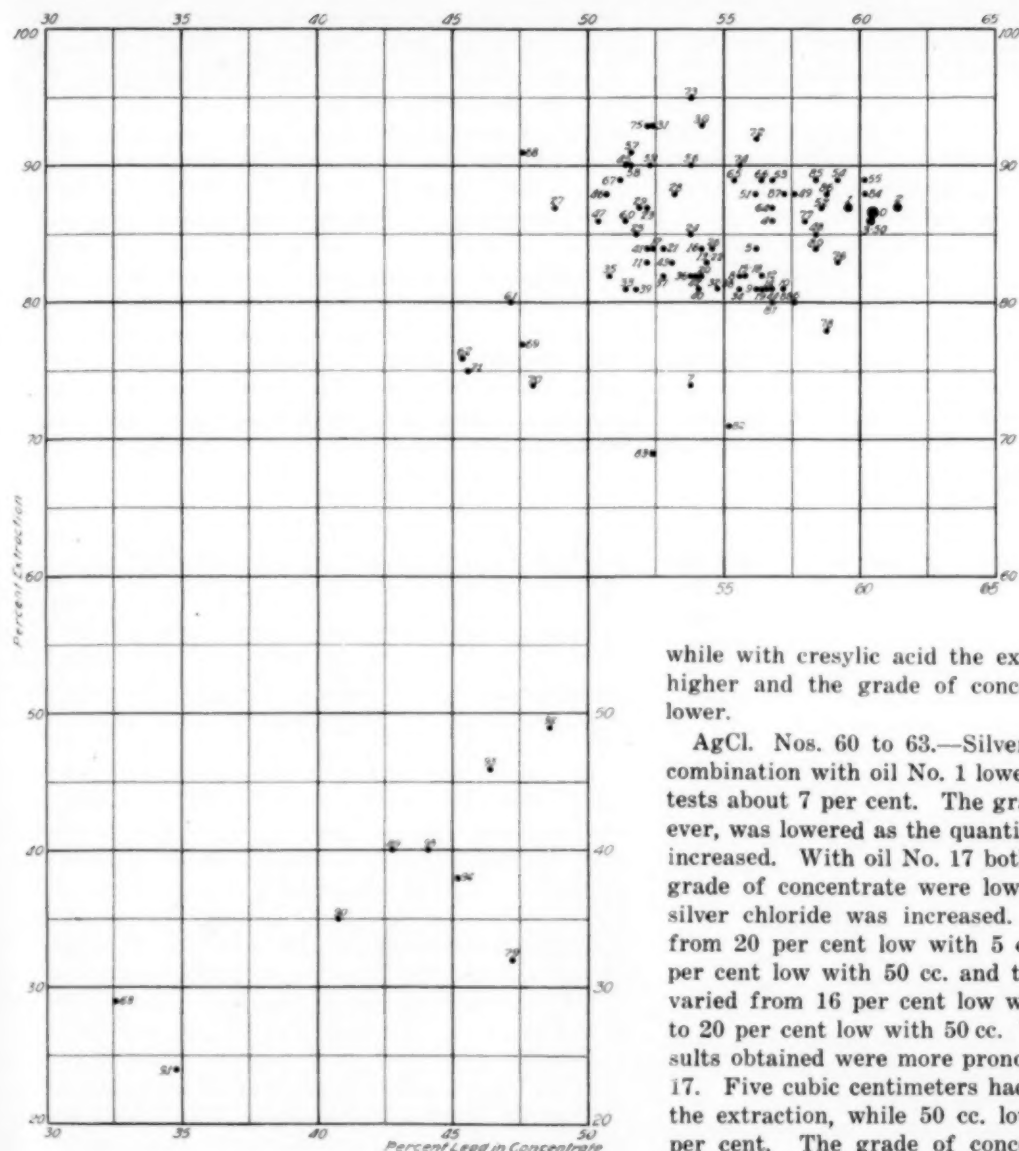


CHART 12. ADDITION AGENTS IN FLOTATION. EFFECT OF CHLORIDES ON THE FLOTATION OF GALENA WITH CRESYLIC ACID

was 5 per cent lower and the grade of concentrate was 6 per cent to 7 per cent lower.

NiCl_2 . Nos. 44 to 47.—Nickel chloride produced results which were more erratic than any of the previous chlorides. Considering the results as a whole, the extraction is better and the grade of concentrate is lower than with either the alkali metal chloride or the alkaline earth chloride.

$\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$. Nos. 48 to 51.—The general action of cobaltous chloride is very similar to that of nickel chloride. The results obtained were more erratic with oil No. 1 and cresylic acid than with oil No. 17. With oil No. 17 an increased quantity of cobaltous chloride increased the extraction and lowered the grade of concentrate.

$\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$. Nos. 52 to 55.—With oil No. 1 ferric chloride lowered the extraction about 4 per cent and slightly raised the grade of concentrate produced; with oil No. 17 both the extraction and the grade of concentrate were lowered 10 per cent, while with cresylic acid the extraction was about $2\frac{1}{2}$ per cent higher and the

grade of concentrate produced was about 12 per cent lower.

$\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$. Nos. 56 to 59.—The effect of cupric chloride, when compared with the effect of previous chlorides, was to produce a low-grade concentrate with little effect on the extraction. With oil No. 1 the extraction was 4 per cent lower and the grade of concentrate was 7 per cent lower; with oil No. 17 the extraction was 12 per cent lower and the grade of concentrate was 16 per cent lower,

while with cresylic acid the extraction was 4 per cent higher and the grade of concentrate was 8 per cent lower.

AgCl . Nos. 60 to 63.—Silver chloride when used in combination with oil No. 1 lowered the extraction in all tests about 7 per cent. The grade of concentrate, however, was lowered as the quantity of silver chloride was increased. With oil No. 17 both the extraction and the grade of concentrate were lowered as the quantity of silver chloride was increased. The extraction varied from 20 per cent low with 5 cc. of the reagent to 35 per cent low with 50 cc. and the grade of concentrate varied from 16 per cent low with 5 cc. of the reagent to 20 per cent low with 50 cc. With cresylic acid the results obtained were more pronounced than with oil No. 17. Five cubic centimeters had practically no effect on the extraction, while 50 cc. lowered the extraction 57 per cent. The grade of concentrate produced varied from 9 per cent lower with 5 cc. to 28 per cent lower with 50 cc.

PbCl_2 . Nos. 64 to 67.—With oils No. 1 and No. 17 lead chloride lowered the extraction 10 per cent and the grade of concentrate 12 per cent. With cresylic acid the extraction was 1 per cent higher, while the grade of concentrate produced was 5 per cent lower.

HgCl_2 . Nos. 68 to 71.—Mercuric chloride with oil No. 1 lowered the extraction apparently 12 per cent and lowered the grade of concentrate about 18 per cent. With oils No. 17 and cresylic acid the quantity used seemed to have little effect on the grade of concentrate produced, which in the case of oil No. 17 was 19 per cent lower and with cresylic acid 13 per cent lower. The extraction depends on the quantity of the salt used, varying with oil No. 17 between 10 per cent to 23 per cent lower and with cresylic acid between 4 per cent higher and 11 per cent lower.

$\text{AlCl}_3 \cdot 6\text{H}_2\text{O}$. Nos. 72 to 75.—The quantity of aluminum chloride used seemed to have little effect on either the grade of concentrate produced or on the extraction. With oil No. 1 this reagent lowered the extraction 13 per cent and the grade of concentrate 11 per cent; with oil No. 17 the extraction and grade of concentrate were lowered respectively 10 per cent and 14 per cent, while

with cresylic acid the extraction was raised 6 per cent and the grade of concentrate was lowered 6 per cent.

$\text{SnCl}_2 \cdot 2\text{H}_2\text{O}$. Nos. 76 to 79.—Stannous chloride had a very detrimental effect on both the extraction and the grade of concentrate produced. Its detrimental action depends on the quantity used, decreasing both the extraction and the grade of concentrate produced, as the quantity of the reagent was increased. With oil No. 1 the extraction varied from 5 per cent lower with 5 cc. of the solution to 46 per cent lower with 50 cc. of the solution, while the grade of concentrate varied respectively from 5 per cent lower to 17 per cent lower. With oil No. 17 the extraction varied from 13 per cent low with 5 cc. of the solution to 69 per cent low with 50 cc. and the grade of concentrate likewise varied from 9 per cent to 28 per cent lower. With cresylic acid small quantities of this reagent had very little effect on either the extraction or the grade of concentrate produced, but when 50 cc. of the solution was added the extraction was lowered 55 per cent and the grade of concentrate was lowered about 10 per cent.

ZnCl_2 . Nos. 80 to 83.—The results obtained when zinc chloride was used varied greatly with the different oils. With oil No. 1 the extraction and grade of concentrate were lowered 8 per cent and 11 per cent respectively, there being little difference in the results obtained with the various quantities of the reagent. With oil No. 17 the extraction varied between 5 per cent and 15 per cent lower and the grade of concentrate varied between 9 per cent and 22 per cent lower, depending on the quantity of the reagent used. With cresylic acid the extractions varied between 3 per cent and 8 per cent lower and the grade of concentrate between 2 per cent and 8 per cent lower, depending on the quantity of the salt used, the points as plotted making a fairly good curve.

BiOCl . Nos. 84 to 87.—The quantity of bismuth oxychloride used had very little effect on either the extraction or the grade of concentrate produced. With oils No. 1 and No. 17 the extraction and grade of concentrate were respectively 10 per cent and 12 per cent lower. With cresylic acid the extraction was about 2 per cent higher, while the grade of concentrate produced was 2 per cent lower.

UCl_4 . Nos. 88 to 91.—Uranium chloride had a very marked effect on the results obtained. With oil No. 1 5 cc. of this salt lowered the extraction and grade of concentrate produced 9 per cent and 6 per cent respectively, while 50 cc. lowered the extraction and grade of concentrate 70 per cent and 29 per cent respectively. With oil No. 17 the extraction varied between 16 per cent low with 5 cc. of the solution to 62 per cent low with 50 cc., and the grade of concentrate likewise varied between 11 per cent and 20 per cent lower. With cresylic acid the extraction varied between 6 per cent low with 5 cc. of the solution to 63 per cent low with 50 cc., and the grade of concentrate likewise varied between 3 per cent and 25 per cent low.

$\text{CdCl}_2 \cdot 2\text{H}_2\text{O}$. Nos. 92 to 95.—Cadmium chloride as in the case of all previous salts containing cadmium had a very detrimental effect on both the extraction and grade of concentrate produced. With oil No. 1 the extraction varied between 28 per cent and 58 per cent lower and the grade of concentrate between 10 per cent and 28 per cent lower. With oil No. 17 the extraction varied between 39 per cent and 58 per cent lower and the grade

of concentrate between 15 per cent and 28 per cent lower. With cresylic acid the extraction varied between 36 per cent and 49 per cent lower and the grade of concentrate between 12 per cent and 16 per cent lower. The experimental work with cadmium salts up to the present time indicate that very small quantities of cadmium have a very marked detrimental influence on both the extraction and the grade of concentrate produced by flotation. Results also indicate that additions of larger quantities of the salt have no more effect than the smaller quantities.

There was nothing special in the action of the chlorides other than the general effect on the extraction and grade of concentrate. The froths are very uniform, generally consisting of small or medium sized bubbles, which break up very quickly.

Experiment Station and Dept. of Met.,
Missouri School of Mines and Metallurgy,
Rolla, Mo.

Increased Output of Crystalline Graphite.—The production of crystalline graphite in the United States was increased last year about 24 per cent, amounting to approximately 6800 tons, against 5466 tons in 1916. About 60 per cent of the output in 1917 was flake graphite suitable for making crucibles; the remainder was dust graphite. These figures are a preliminary estimate of the Geological Survey.

The production from the Alabama field, instead of being more than double that of 1916, as would have been expected from the large number of new companies entering the field, shows only a slight increase, for owing to freight embargoes the Alabama producers have been unable to market their product. The other producing fields have made notable increases in production but not sufficient to increase greatly the total output.

The imports of crystalline graphite in 1917 as shown by the records of the Bureau of Foreign and Domestic Commerce for the first ten months and as estimated for November and December, amounted to more than 32,000 tons, of which 25,000 tons came from Ceylon. If the Alabama producers could have had free access to the markets a much larger proportion of our needs could have been supplied from domestic sources.

The value of the graphite produced in 1917 is considerably greater than that produced in 1916, for No. 1 flake has commanded a higher price and many of the mills marketed a larger proportion of this grade in 1917 than formerly.

Figures showing the production of amorphous graphite are not yet available.

Chimie & Industrie.—The first issue of *Chimie & Industrie*, the official journal of the recently formed Société de Chimie Industrielle of France, has appeared. It contains a statement on the aims of the society, its program and organization and the fields to be covered by the journal, which will appear monthly. The editor-in-chief is Prof. Camille Matignon of the Collège de France. Judging by the appearance of the first number and the advertisements contained therein, the journal should prove successful. It has indeed made a very good start. The best wishes of this journal go to our brothers in France and we look forward to seeing it play an important part in the industrial development of that country. The recently formed New York Section of the Society now has about 165 members.

Ceramics and the War*

BY EDWARD W. WASHBURN†

AT the time this building was dedicated last year one of the professors at a neighboring university happened to see one of the dedication pamphlets bearing a picture of the new Ceramics Building upon it, and he was curious as to why such a large building should be constructed for such a subject as ceramics. It appears that he was under the impression that the term "ceramics" was applied to the art of deciphering the ancient cuneiform inscriptions which the Assyrian and Babylonian peoples made on clay tablets. This incident illustrates in a way the condition which exists in the mind of the average man regarding the subject of ceramics. Either he has never heard the term, and consequently it conveys no meaning whatever to him, or else he perhaps associates it only with the beautiful vases and the ancient pottery which he sees in the museums. Certainly the average man would be astonished if he were told that the science and art of ceramics was of the utmost importance in the prosecution of a war. It is nevertheless a fact that modern warfare could not be conducted without the assistance of the ceramic engineer and artisan, and I wish to point out briefly at this time some of the fields in which ceramics is indispensable to a nation engaged in war.

I will begin my subject by telling you a story of the way in which the importance of one branch of this subject was first brought home to the English people early in the war. Not long after the war started, a committee from the British steel manufacturers waited upon the British government and stated that as far as they could determine their factories would be able to continue operation for only a few weeks longer, after which they would be obliged practically to shut down. Of course, that was a very serious state of affairs for a country just entering upon a big war, and the government and people would naturally be alarmed at such a prospect, and curious as to the causes which produced it. Now, if one were to ask the average citizen to hazard a guess as to a probable cause for the closing down of the steel works of a country he would probably think of labor troubles or transportation difficulties, or perhaps lack of ores or fuel, or other raw material; but I venture to say that the true source of the difficulty which confronted the English manufacturers would never be suspected. As a matter of fact, the crisis in which the British manufacturers found themselves was caused by the fact that the supply of chemical glassware in England was approaching exhaustion, and since all of this glassware had been imported from Germany, there appeared to be no way of renewing the supply. Now, a modern chemical laboratory cannot be operated without a variety of different kinds of vessels and apparatus constructed from a special kind of glass, and when the laboratory of a steel works ceases to function the plant can no longer operate, since it is operated entirely under the control of its laboratory. The chemists of Great Britain were appealed to in the crisis, and they immediately set to work to find out how to make chemical glass, and fortunately they were able to solve the problem before the crisis became acute; but for a

while the government was very much alarmed, and at one time an inventory of all the chemical glassware in the kingdom was contemplated so that it could be confiscated, if necessary, for the national needs. Before such a necessity arose the chemists had found out how to make a sufficiently good grade of chemical glassware to meet the immediate needs.

Curiously enough, about the same time the coal miners were confronted with a similar situation, and here again the source of the trouble was glass. The kind of glass used in miner's lamps had been obtained entirely from Germany, and since the safety of hundreds of miners was dependent upon the heat-resisting power of the glass in their lamps, it was evident that this problem also required an immediate solution. Both of these problems are in the realm of ceramic chemistry, and both of them were solved by the British chemists before the situation became a dangerous one.

The immediate appearance of these two, so to speak, ceramic crises in England called attention to a situation which had existed in England for a long period of time. During the decade immediately preceding the outbreak of the war, British chemists and physicists had repeatedly directed the attention of the public to the importance of scientific education and scientific research, and had warned the country of the dangers which threatened both its industrial and its political life because of the failure of the government to appreciate the backwardness of the nation in this respect, and because of the resultant dependence of the country upon Germany for many essential materials. It is well known that the backbone of Germany's war strength has been her chemists, and a large element in the weakness of Great Britain early in the war arose from her state of scientific unpreparedness in many chemical lines and the failure of the government to make sufficient use—even after the outbreak of the war—of the chemical resources which the nation already possessed, and the utter ignorance on the part of the British officials of some of the simplest chemical facts of first importance in the conduct of the war. One illustration of this ignorance occurred during the early days of the war, when the British government prepared its first list of contraband of war. This was before the days of the food blockade, when foodstuffs were still allowed to be sent into Germany. All manufactured munitions and all materials which were used in the manufacture of munitions were declared contraband of war. Nevertheless, under the guise of food, large quantities of lard and other fats were imported by Germany without any attempt on the part of Great Britain to prevent it. Finally the attention of the government was called to the fact that it was permitting Germany to import all the lard which she wanted, and that the Germans were making munitions of war out of the lard. Now, lard is one of the principal sources of glycerine, and when glycerine is treated with a mixture of sulphuric and nitric acids a rather important article known as nitroglycerine is the result. But apparently no one connected with the British government was aware of this fact, and when attention had been called to it by the chemists of the country one of the public officials of Great Britain is said to have stated in defense of the government that the manufacture of nitroglycerine from lard was a *recent German discovery*, and that consequently the British government could not be expected to know of it.

*A talk before the students of the Short Course in Ceramic Engineering at the University of Illinois, Jan. 11, 1918.

†Professor of Ceramic Chemistry, University of Illinois.

This example illustrates fairly well the condition of affairs in Great Britain in the early days of the war. These conditions have, of course, been remedied to a large extent since the war started, because English scientific unpreparedness, as contrasted with Germany's high state of scientific preparedness, was not in any way due to the fact that Germany had better chemists than England, for such was not the case; the difference was due to the fact that the German government and people appreciated the importance of scientific education, scientific research, and the application of science to industry, while the British government and her people did not.

But to return to the subject of ceramics and the war. In addition to the problems of chemical glassware and of heat-resisting glass already mentioned, one other glass problem of still greater importance had to be solved. I refer to the matter of optical glass, about which we have heard a great deal since our own country entered the war. Optical glass, as you know, is needed for the manufacture of telescopes, binoculars, officers' field glasses, range finders, and telescopic sights for the artillery, submarine and trench periscopes, photographic lenses and photographic plates for army and navy observation purposes, and X-ray bulbs and microscopic lenses for the medical and sanitary corps. Previous to the war, Germany manufactured about 100 different kinds of optical glass, which she shipped to all parts of the world. England manufactured about 20 different kinds, and the United States manufactured none whatever. The twenty kinds manufactured by England were not sufficient in number, nor was the output anywhere near sufficient to supply the British army and navy. In fact, in addition to stimulating the manufacture of optical glass the British government was obliged to collect from private individuals large numbers of field glasses and small telescopes, and even as recently as six months ago the output of optical glass, although many times greater than it was before the war, was still apparently insufficient to provide for all of the glasses needed by the army and navy.

When America entered the war she was, as you know, also brought face to face with this same problem in ceramic chemistry, and the country was obliged to turn to its chemists for assistance. Under the able direction of a special committee on optical glass, composed of Major H. A. Millikan, professor of physics at the University of Chicago; Dr. Arthur L. Day, director of the Geophysical Laboratory of the Carnegie Institution; and Dr. S. W. Stratton, director of the U. S. Bureau of Standards, research in the manufacture of optical glass has been vigorously prosecuted both in the Geophysical Laboratory, under Dr. Day's direction, and in the Bureau of Standards' Laboratories at Pittsburgh, under the direction of Mr. A. V. Bleininger. As a result of these investigations, and with the co-operation of some of the largest glass manufacturers of the country, there is now being manufactured in America all of the different kinds of optical glass which are most urgently needed by the army and navy; and although the output is, as yet, not quite as large as we would like to have it, the situation is improving every day, and the crisis with which the country was threatened may be considered as safely past. In fact, there seems to be no likelihood that the glass situation, as a whole, will ever become as acute in this country as it did in Eng-

land, where a special officer having the title of Director of Optical and Glassware Munitions was appointed and placed in charge of all glass production, purchase and sale in the United Kingdom. No kind of glass or glassware can be manufactured, bought or sold in England without a license from this officer.

The second big field of ceramics which is of fundamental importance to the industrial life of a nation, both in time of war and in time of peace, is the field of refractory materials. Every industry which uses high temperatures in any part of its process has a more or less acute problem of refractory materials. Even where the only high temperature employed is in the power house of the plant there still exists a rather important ceramic problem, for the life of a boiler setting depends upon the proper adaptation of the refractory material employed to the chemical action of the fuel gases and to the abrading action of ashes and cinders, as well as to the direct action of the high temperature itself. In industries such as the metallurgical industries, which employ very high temperatures, the problem of refractory materials is, of course, of still greater importance. In fact, it is not too much to say, that, other things being equal, the rate at which a country can produce munitions of war is very closely connected with its supply of suitable refractory materials because the character of such materials determines the frequency with which furnaces have to be closed down for relining. A great many refractory materials, such as fire brick and other fire-clay articles, silica brick, chrome brick, magnesite brick, dolomite, bauxite, graphite, porcelain, alundum, zirconia, etc., are manufactured and employed in the different industries, each industry having its own special refractory problems, since the conditions of temperature, chemical action, abrasion, etc., are different in the different industries, and the refractory has to be adapted to withstand the special conditions of each industry.

Among the porcelain refractories may be mentioned the special electrical insulators for high-tension transmission lines, as well as the insulators for ordinary voltages in buildings, cars, and on ships; sanitary porcelain; the porcelain employed by the chemist in the form of crucibles, casseroles, etc.; the particular variety of porcelain used in protecting pyrometer tubes; and the porcelain spark plugs which are so important in the aeroplane. Indeed, the length of time which an aeroplane can remain in the air is not infrequently determined by the character of its spark plug, since an improperly constructed spark plug deteriorates rapidly under the influence of the high temperatures to which it is subjected during the operation of the engine. We thus see that ceramics has an important and close connection even with the subject of aviation. In the case of chemical porcelain and the special porcelain for manufacturing pyrometer tubes, the ceramic chemists of this country have had to discover the methods of manufacturing these materials, since they were purchased from Germany previous to the war. Fortunately, the investigations of our ceramic chemists on these two subjects have been entirely successful, and we can manufacture, and are manufacturing, porcelain of this character which is just as good, if not better, than that which was previously imported from Germany. Among other ceramic products which are more or less important in time of war the following may be mentioned:

1. Enameled iron products, such as autoclaves, kettles, and evaporators, which are used in ammunition manufacture. The manufacture of an enameled lining which will stand up under the pressures, temperatures and chemical action to which it is subjected in these processes is quite a problem. The less important application of enameled ware, in the form of cooking vessels in the army canteens and kitchens, may also be mentioned.

2. The manufacture of abrasive wheels, of which large numbers are used in the manufacture of artillery, is an important ceramic industry, and the proper bonding material for use in the manufacture of such wheels is a ceramic problem which still requires considerable investigation.

3. The purification and treatment of ceramic raw materials, such as clays, sand, bauxite, etc., in order to adapt them for the needs of the manufacturer, is also one of the most important ceramic subjects at the present time.

The foregoing outline of ceramics and its relation to warfare will serve, I hope, to convey a general idea of the many and varied ways in which the ceramic industries of the country are of fundamental importance to the nation's welfare and to its ability to properly prepare itself for war. The need for scientifically trained ceramic chemists and ceramic engineers has never been so great as it is at the present time. The country could easily absorb ten times as many technically trained men of this character as it is now producing, and it ought to be the duty of every man who appreciates the situation to do everything he can to stimulate the production of such men. I think one of the reasons why so few college men take up ceramics as a life work is because of the ignorance on the part of the general public as to the significance and importance of this subject, and I hope that each one of you will make it a point to call the attention of the young men in your own community to the importance of this field and to the excellent prospects which it holds out to a young man who will properly train himself in this subject. There ought to be a very rapid growth in all of the ceramic schools of the country during the next ten years, but I am certain that even the most rapid growth which we are likely to have will still fall far behind the still greater growth in the demand for such men, because of the fact that the great ceramic industries of the country, employing thousands of men, and representing an investment of many millions of dollars, are just beginning to wake up to the importance of applied science and to the necessity of employing technically trained men for directing their operations and solving their difficulties.

Great as is the present demand for such men, I am sure that in the next decade we are going to see this demand multiplied manifold, and I hope that every one of you will on every possible occasion make known to the young men of your acquaintance the excellent prospects which the career of ceramic chemist and ceramic engineer holds out to them.

Nichols Medal Award—The jury of the Wm. H. Nichols Medal of the New York Section of the American Chemical Society awarded the medal for the calendar year 1917 to Treat B. Johnson of the Sheffield Scientific School of Yale University, for his work on pyrimidines.

Sulphuric Acid Production in 1917

More sulphuric acid was produced in the United States in 1917 than in any previous year, according to the Geological Survey. A moderate estimate shows that the increase in the production of acid of all strengths in 1917 over that in 1916, stated in terms of 60-deg. B. acid, amounted to at least 600,000 tons.

It is not yet possible to state accurately the production of sulphuric acid in 1917 according to strengths, for some of the companies that produce 50-deg. 60-deg. and 66-deg. acid have reported their entire production together and so stated it as if they had made only 100 per cent acid. Now, 100 per cent sulphuric acid is above 66 deg. B. and is here reported as "stronger acid," but, in view of the fact stated, a certain quantity of the stronger acid reported should really be carried as acid having a strength of 66 deg. B. or less. However, as no data are available to show the proper distribution of all the acid made in 1917, the following table has been prepared as if the reported production were the actual production:

Strength of Acid	1917 Short Tons	1916 Short Tons
50 deg.	2,306,372	1,829,471
60 deg.	1,187,704	1,119,753
66 deg.	850,000	1,580,100
Stronger acid	1,190,019	443,332

In comparing the production reported for 1917 with that for 1916, only acids of similar strength should be compared. For instance, the amount of acid of 66 deg. B. reported for 1917, namely, 850,000 tons, is equivalent to 1,290,000 tons of 50-deg. acid. In other words, the sum of the amounts of the different acids as given above for 1916 and 1917 should not be compared to show the output in the two years, for the great increase in the output of the stronger acids would represent a much larger increase in that of the weaker acids.

The condition of the market for sulphuric acid in 1917 is reported to have been on the whole even better than in 1916, and the value of the product was considerably higher than it was during that year of high prices. Some companies have had difficulty in obtaining sufficient sulphur ore and many of them have been compelled to change from pyrite to sulphur burners. Experiments in the greater utilization of pyrrhotite have been carried on and attempts have been made to find domestic deposits of pyrite that can be used if the supplies of foreign ore are curtailed under the conditions imposed by the war.

Nearly 98 per cent of the manufacturers reported their production, and that of the others was estimated from previous records. It is believed that the totals of these preliminary figures will approximate very closely the final figures, which will be made up when the complete returns are received, although the quantity of acids of different strengths as stated may require considerable readjustment.

Red Cross Wants Used Tracing Cloth.—The American Red Cross is desirous of having manufacturers, draftsmen and all those having old tracing cloth which is of no value to them send it to a local laundry or Laundry Owners' Association, where it will be washed and delivered to the Red Cross. An appeal has been made to laundries to undertake the work and it is felt that considerable linen, of which there is a shortage, can be furnished in this way.

The Trumble Oil-Refining Process

AT the annual meeting of the American Institute of Mechanical Engineers, in December, N. W. THOMPSON of the Simplex Refining Co. of San Francisco presented a description of a new oil-refining process known as the Trumble process. The chief advantage claimed for the process is the conservation of heat. It was stated that a plant operating under this system was doing—on 1.1 per cent of the crude oil run through as fuel—more work than large oil refineries using as fuel 4 per cent of the crude oil.

In Fig. 1 is shown a Trumble evaporator, to which in this case is connected an evaporator column. The evaporator consists of a closed cylindrical metal shell, vertically disposed, to which heat is applied from the outside in any convenient manner, as, for example, by flue gases or by vapors from another evaporator.

Inside the evaporating chamber is arranged a central vertical pipe having umbrella-shaped devices attached

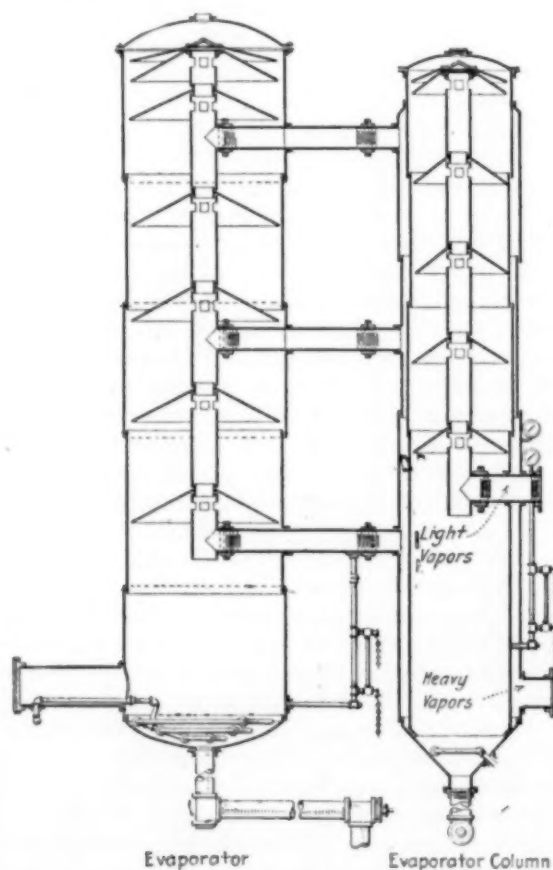


FIG. 1. EVAPORATOR AND EVAPORATOR COLUMN

thereto at intervals, which are called "spreader hoods," so that oil fed to the apex of these hoods will flow down over their sides in a thin film after the analogy of rain flowing down the outside of an umbrella. The lower edges of these hoods are at a little distance from the sides of the wall of the evaporating chamber, and in operation the oil flows down and over the hood and strikes against the interior wall of the evaporating chamber and flows down the wall in a thin continuous film.

In case any of the oil should not strike against the wall in the evaporating chamber, but should drop off the edge of the hood and fall vertically; or in case there

should be a tendency to bubbling or foaming on the wall of the evaporating chamber whereby a portion of the oil may be thrown back toward the center of the evaporating chamber, such oil will be caught by the next spreader hood and will flow down the surface thereof, thereby insuring an ultimate spreading of the oil on the wall of the evaporating chamber.

The oil to be operated on is fed through a supply pipe to the top of the evaporating chamber, and discharges downward on the apex of the uppermost hood. The oil then flows down this hood in a thin stream, and is delivered against the interior wall of the evaporating chamber as herein above described.

The centrally arranged vapor take-off pipe in the evaporating chamber, to which the spreader hoods are attached, is provided with perforations underneath each of the hoods, and through these perforations the vapors pass from the evaporating chamber into the vapor take-off pipe. Located in this vapor take-off pipe are lateral branch pipes, and these branches extend through the wall of the evaporating chamber to the outside of the apparatus.

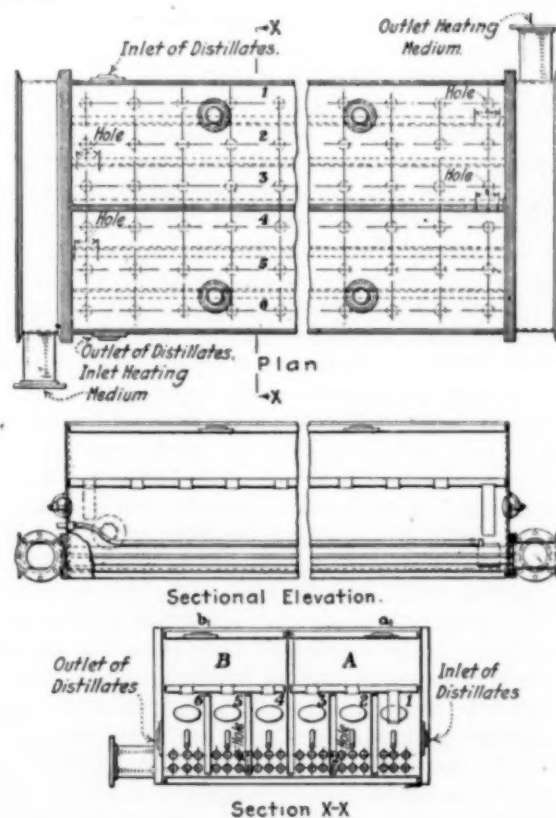


FIG. 2. SEPARATOR

Fig. 2 shows the construction of the separator. This is a re-run still for distillates from bottoms of dephlegmators, or from any other source, if these need fractionating. The distillate flows into compartment (1) over a number of pipes through which a heating medium is passed, either residuum or vapors, as the case may be, and then passes through an opening at end of compartment (1) into compartment (2) and back through compartment (3) and so on, leaving at the end of compartment (6). The vapors evolved in compartments (1), (2) and (3) pass through openings into vapor compartment B and out through opening b_1 to condenser, etc.

The manifolds on the ends of the separators are pro-

vided with covers having stuffing boxes through which valves are operated to regulate the flow through tubes in each compartment, thereby controlling the heat in these compartments.

The flow of the crude oil through the plant is indicated by the flow sheet in Fig. 3. The oil enters through a 6-in. line and is used as a cooling medium in the six coolers shown. These coolers are of the horizontal tubular type, 30 in. in diameter, with sixty-two 2-in. by 18-ft. tubes. The oil enters at the bottom and passes through the tubes, making four passes, and comes out at the top and goes into a header, through which it passes into the four heat exchangers or coolers for the residuum.

These heat exchangers are 48 in. in diameter, and have 178 2-in. by 18-ft. tubes. The crude oil enters the first heat exchanger at the bottom and passes through the tubes, making six passes, and out at the top into the bottom of the next exchanger, and so on, to the heater pipes, where it is split in two, each half passing in series through seventy-two 18 $\frac{3}{4}$ -ft. lengths of 4-in. pipe, flowing back and forth and upward at all times, and then into the top of the evaporator, where it flows down the sides in a thin film.

The oil, in passing through the heater pipes and evaporator, is heated by the flue gases. The vapors evolved are separated in the evaporator and taken care of later. The oil is maintained at a constant level in the bottom of the evaporator and runs out of the bottom of it as residuum. A perforated steam coil is placed in the bottom of the evaporator under the liquid and superheated steam is passed through it in order to drive off any of the lighter distillates which may drop back from the vapors. However, very little steam is necessary in this case, as the heat losses are supplied by the flue gases.

After leaving the evaporator the residuum is used as a heating medium for redistilling the distillates passing through separators, and then flows through the heat ex-

changers counter-current to the crude oil. The residuum enters the first heat exchanger at the top and makes two passes around the tubes and out at the bottom, then into top of the second exchanger, and so on through the five heat exchangers and through a standpipe, which is vented, and which controls the head of residuum in the bottom of the evaporator, and then to the storage tanks.

The vapors from the central vapor column of the evaporator are taken out through a shell and connected into a header. The vapors pass from this header through an oil catcher similar to a steam separator, the condensate passing out of the bottom of it into the bottom of the evaporator. They then pass through six large dephlegmators in series, flowing into the bottom of each and out at the top. In each dephlegmator a partial condensing of the vapor takes place, thus forming a liquid in the bottom of that particular dephlegmator. From some of the dephlegmators this condensed liquid is a ready product—from others it is just between two different products.

A system of water circulation is used as a cooling medium for the vapors from the dephlegmators and separators. The vapors are cooled in vertical tubular condensers, and about twenty barrels of water are required per barrel of distillate cooled. Superheated steam is used in the bottom of the evaporators, separators and dephlegmators as an agitator to relieve the lower boiling point fractions from the bottom. About 30 lb. of steam are used to each barrel of distillate produced.

Mr. Thompson said it is possible to save by proper distribution of the heat available around the oil refineries in the United States at least 2 per cent of the total crude oil put through these refineries. He said there are large oil refineries operating to-day that are using as fuel 4 per cent of the crude oil run through them to do less work than the plant described is doing on 1.1 per cent of the crude oil run through as fuel, and the losses due to non-condensable gases, etc., are 2 per cent against 0.75 per cent.

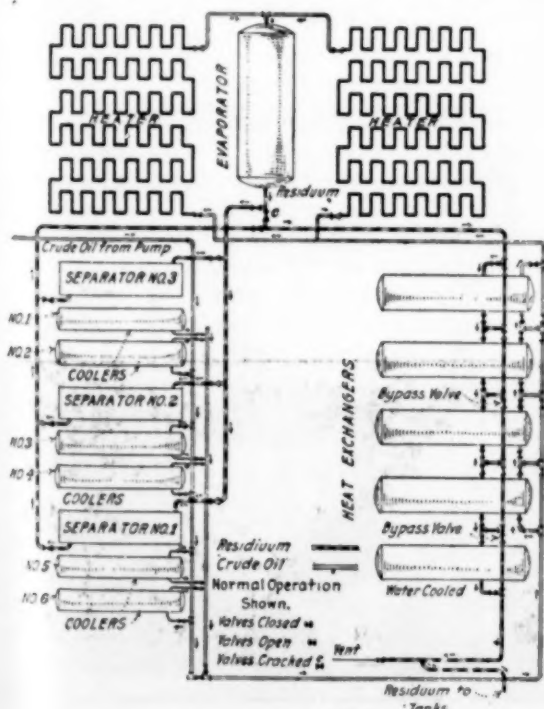


FIG. 3. CRUDE OIL AND RESIDUUM SYSTEM

Cost of Refining Gasoline.—The Federal Trade Commission has obtained data on the cost of producing gasoline in August, 1917. The figures are the result of distributing the actual total refinery costs to the various refined products on the basis of the values of the various products. The costs are based on 55 refineries in all parts of the United States. They are given in the following table:

REFINING COST PER GALLON OF GASOLINE			
1—NEW JERSEY AND EASTERN TERRITORY			
	Low Cents	High Cents	Representative Cents
Cost of crude oil.....	12.0784	13.9575	12.7348
Cost of refining.....	2.0271	3.9570	4.8836
Total	14.1055	17.9145	17.6420
2—INDIANA AND NORTH MISSISSIPPI VALLEY			
Cost of crude oil.....	9.8212	12.8827	11.5120
Cost of refining.....	1.3620	3.8621	2.1630
Total	11.1840	16.7448	13.6750
3—OKLAHOMA			
Cost of crude oil.....	9.8804	15.2620	11.1860
Cost of refining.....	1.5196	2.3740	3.4856
Total	11.4000	17.6360	14.6706
4—GULF COAST			
Cost of crude oil.....	11.5670	14.5774	13.6608
Cost of refining.....	.8520	1.7579	1.8074
Total	12.4190	16.3353	15.4682
5—CALIFORNIA			
Cost of crude oil.....	9.8683	12.2033	11.7400
Cost of refining.....	1.8743	4.3112	1.7800
Total	11.7426	16.5145	13.5200

Plate-and-Frame Filtration

BY D. R. SPERRY

FILTRATION within a filter-press may be carried on by means of plates and frames.

FLUSH PLATES

In Fig. 1 is shown a filter plate which can be used only with frames. It will be noted that this kind of plate appears somewhat like the recessed type. The feed-channel is formed by an eye in the upper corner, but is plainly not to be used with grommets. Fig. 2

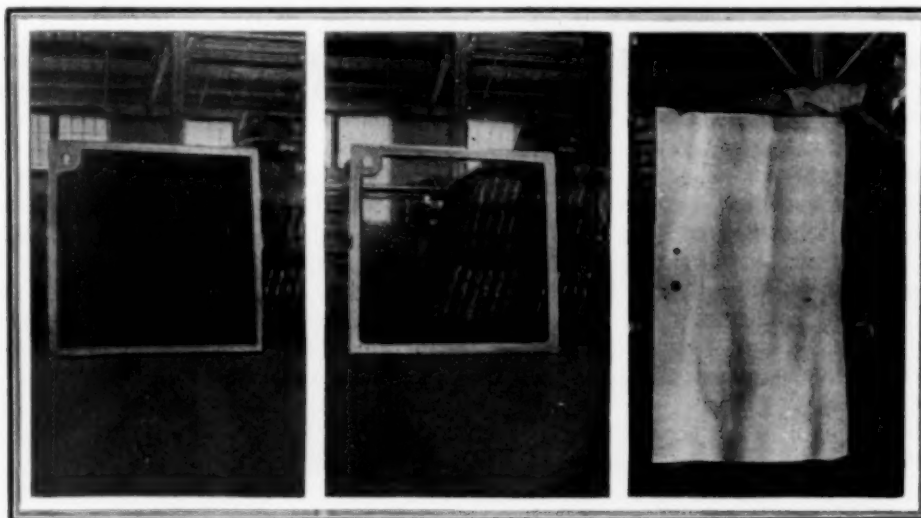


FIG. 1

FIG. 3

FIG. 5

shows this plate in cross section. Here it can be observed that there is practically no recess in the surfaces whatever and that the hole in the upper corner, called an eye, is much smaller in diameter than that found in the recessed type of plate. The surface surrounding the hole is also flush with the packing surfaces of the plate and has no connections with the filter surfaces or interior of the plate. The grooves on the filtering surfaces lead directly to the outlet, precisely as is the case in the recessed plate. This plate is distinguished from the recessed type of plate by the name of "flush plate."

FRAMES

In Fig. 3 is shown a frame used in conjunction with the flush type of plate. In general this consists of a flush plate without a center panel. In other words, if the center of a flush plate be cut away up to the packing

surfaces, it would have the same general appearance as a frame. In Fig. 4 a frame in cross-section is shown. Especial attention is called to the fact that the corner eye has a connection to the interior of the frame and does not go merely straight through from packing surface to packing surface as is the case in a flush plate.

CLOTHING

In order to use a flush plate-and-frame filter-press, the plates and heads are first clothed. To do this cloths are cut for each plate which are long enough to lay over the top of the plate and extend over each filter surface

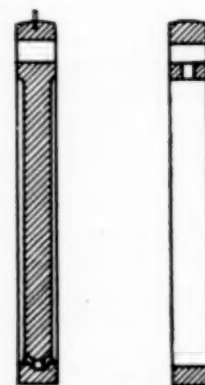


FIG. 2

FIG. 4

and beyond the packing surfaces. A hole is cut in the cloth where it covers the eye in the plate. A cloth cut

and ready to be applied to a flush plate is shown in Fig. 5.

A photograph of a cloth in position over a flush plate, but partly lifted to show plate surface, is given in Fig. 6. Two locating pins are placed on the top edge of each plate by means of which the filter cloth is held in position and kept from falling. These are called dowel pins.

CLOTHING THE HEADS

When the plates are thus clothed it is necessary to cut smaller cloths to place over the filter and packing surfaces of the heads. The cloth on the slide head has no hole cut in it, as none is required. The one on the fixed head, however, has a hole cut in it where the cloth covers the inlet eye. Photographs of slide and fixed heads showing how the cloths are applied are shown in Fig. 7 and 8. It should be understood

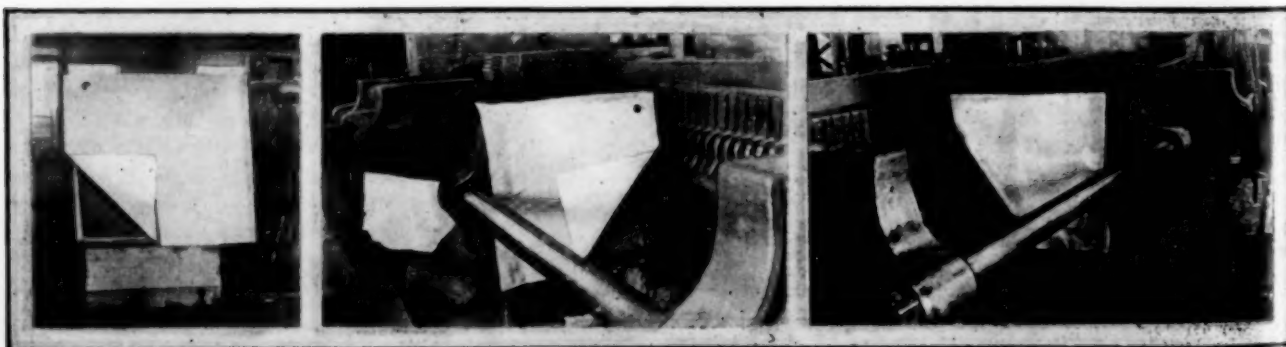


FIG. 6

FIG. 7

FIG. 8

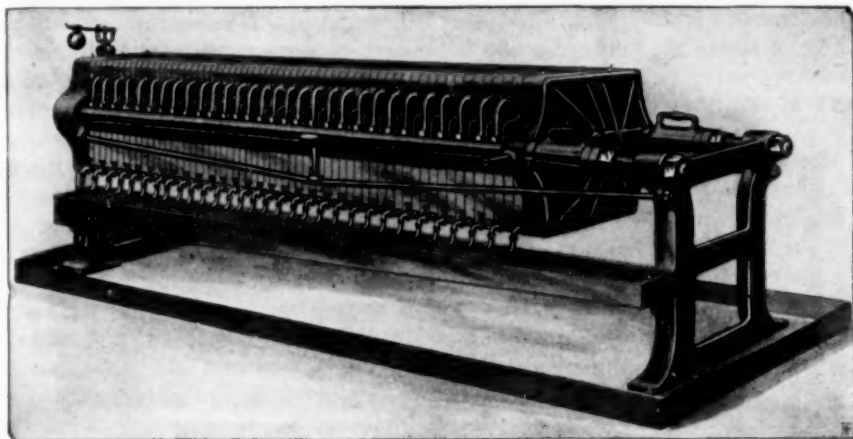


FIG. 9

that dowel pins are supplied on the upper edge of the heads to hold the cloths in position.

PRINCIPLE OF OPERATION

When all of the plates and both heads are clothed, the plates and frames are placed within the filter-press alternately, that is, a frame is placed between each

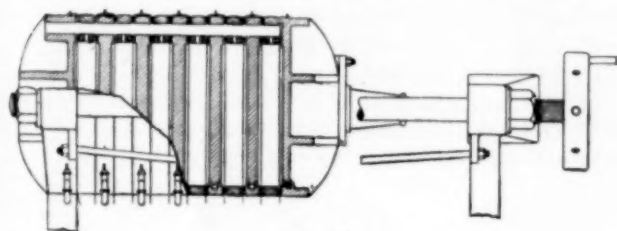


FIG. 10

pair of plates and between plates and heads. Thus there is always one more frame than there are plates. A filter-press of the flush plate-and-frame type with all the plates and frames in position is shown in Fig. 9. The plates can be easily distinguished from the frames by the cocks which are on the plates only.

The eyes in the plates and frames are so located that



FIG. 11

when they are in the filter-press they register with each other, beginning with the eye in the fixed head. In other words, if one were to look in the feed inlet on the fixed head, it would be found that a continuous channel is formed by the eyes, running the whole length of the filter-press. Tapping into this channel would be, of course, the connections leading to the interior of the frame.

frame, eventually completely filling the same. When this happens there is no way for anything to escape except through the cloth. The liquid does the latter and upon emerging on the opposite side of the cloth is conducted along the grooves of the plate surface directly to the outlet corner and out via the cocks. The solids, unable to pass through the cloth and the accumulated

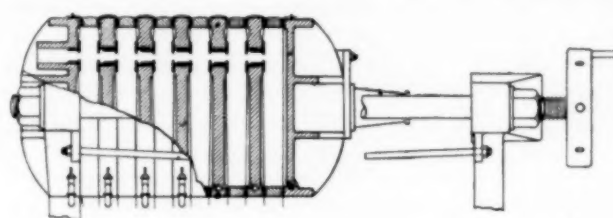


FIG. 12

solids, are retained within the frame. Eventually the frame becomes completely filled with solids and the filter-press is said to be filled. When this has occurred, the material to be filtered is no longer fed into the filter-press and the screw of the filter-press is loosened. The slide head is then pulled back as far as it can go and the adjacent frame slid up and cleaned of its contents of cake. The first plate is then drawn up and the next frame cleaned, and so on, until all of the frames are relieved of their contents. When this is completed, the empty frames and plates are slid back into their proper positions for the next fill.

FRAMES WITH GROMMET FEED PLATES

Frames having no eyes whatever can be used in conjunction with plates having the grommet type of feed. Such a frame is shown in Fig. 11. It can be readily understood how a frame of this type could be inserted between plates of the recessed type and have the effect merely of increasing the cake thickness or chamber capacity. In case the plate were not made recessed but flush, still retaining the grommet feed, the eyeless frame could still be placed between adjacent plates and form a chamber in a somewhat similar manner to that done in the flush plate-and-frame type. A cross-section of a grommet flush plate-and-frame filter-press is shown in Fig. 12. The plates, frames and heads are clothed in a manner similar to that described for the recessed type of plate. A study of Fig. 12 shows that a channel from end to end of the filter-press is formed

by the grommets and the interior of the frames. The end of the channel is formed by the slide head, which has no grommet hole. When the material to be filtered is fed into the inlet, it runs the full length of the filter-press through the grommets and frames. In so doing it fills the interior of each frame. The pressure exerted upon the material by the pump or whatever feeding device is employed, causes the liquid to flow through the cloth which bounds each frame, onto the plate surface back of the cloth and thence via the grooves to the cock placed on the lower corner. The manner of opening and cleaning the filter-press is similar to that described for the flush plate-and-frame type.

Batavia, Ill.

Synopsis of Recent Metallurgical and Chemical Literature

Absorption of Gold in Bone-Ash Cupels.—F. P. DEWEY presents the results of four years' observations at the mint, in a paper entitled "Bone-Ash Cupels," to be presented at the February, 1918, meeting of the American Institute of Civil Engineers. In all, about 100 varieties of bone ash have been tested, and probably 10,000 or more used cupels have been assayed. The result of this investigation is a most emphatic warning against drawing conclusions regarding cupels and cupellation from insufficient data. From the vast accumulation of data now on hand, I can pick out isolated illustrations here and there to support any reasonable supposition and also a great many unreasonable and contradictory ones regarding the subject. Again I can pick out many apparent exceptions to every general rule.

The second result is to emphasize the difficulty of carrying on several sets of cupellations under even approximately the same conditions.

The third result is that rigid conclusions regarding bone ash, cupels and cupellation call for such a vast amount of painstaking detailed work under such onerous conditions that the game is scarcely worth the candle, especially as the customary variations occurring in practical work will nullify many such conclusions.

Finally, then, the results of this work cannot be dealt with in any dogmatic way, but they must be applied in a general and practical way with reasonable consideration and caution.

There have been many investigations of cupels and the most diverse views have been expressed, the extremes being the statements of Lodge¹ that every cupel has some effect upon the loss in assaying telluride ores and of the Campredons² that coarse and fine and hard and soft cupels all give the same loss of silver when cupelling the same weights. The truth lies between these statements and much nearer the latter. In a vast majority of cases the influence of the cupel is not dominant and is outweighed by other conditions, particularly the temperature of the cupelling bead.

¹R. W. Lodge: Assaying Telluride Ores for Gold. *Technology Quarterly* (1899), 12, 171.

²G. Campredon: Importance des différentes causes de pertes d'argent à la coupellation. *Revue Universelle des Mines*, Ser. 8 (1904), 8, 210.

In following this matter up, for the purpose of increasing the accuracy of our commercial methods of bullion assays, the question of the absorption of gold by the cupel was found to be a most important one and was taken up for investigation. In a lesser degree, the silver absorption is important and interesting, but at present it appears to be far more complicated and much further investigation is required to put the subject upon a satisfactory basis.

In assaying high-grade products giving large assay buttons, the following general conclusions may be drawn: Within wide limits the screen composition of the bone ash is not the dominant factor in cupellation, but the assayer should inform himself as to the grades of ash available and adopt some plan in selecting or mixing his ash. In the same way the pressure used in making cupels is not highly important, although it is well to keep it fairly uniform. There is no necessity to season cupels. In making comparative tests the closest attention must be given to the temperature question, but the temperature of the cupelling bead is for the present beyond either measurement or control, and high general temperature in the muffle may produce wide variations in the absorption of gold in adjoining cupels. The pyrometer is a good guide to the general temperature conditions, but uniformity of pyrometer reading does not mean uniform bead temperature.

In assaying ductile fine gold, for instance, it is evident that the gold absorption by a cupel may be kept down to 0.1 mg. and need not exceed 0.2 mg. Certainly an absorption of over 0.25 mg. should not be countenanced in fine-gold assaying. In the case of coin gold the figures might be increased by 0.05 mg.

The careful assayer should establish standards of cupellation suitable for his particular lines of work and should assay his used cupels from time to time to see that the standards are being maintained. The conditions of the cupellation are far more important in influencing the cupel absorption than the structure of the cupel. When high or erratic losses are shown the used cupel should first be examined for beads. In the absence of beads the other conditions, especially the temperature, should be carefully considered before blaming the cupel.

Iron and Steel

Copper in Medium Steel.—C. R. HAYWARD and A. B. JOHNSTON have presented a paper before the New York meeting (1918) of the American Institute of Mining Engineers on "The Effect of the Presence of a Small Amount of Copper in Medium-Carbon Steel." Two analyses were investigated, as follows:

	High Copper	Low Copper
C	0.380	0.365
P	0.012	0.053
Mn	0.570	0.590
S	0.030	0.048
Cu	0.860	0.030

The bars, turned to $\frac{3}{4}$ in., were heated to 845-865 deg. C., quenched and drawn in various ways. The unannealed bars were too hard to turn on a lathe. A 7-in. length was therefore used and the ends annealed in a blacksmith's forge to allow the cutting of the threads. During the heating, the center was kept cool

with water. A 2-in. gage length was then ground at the center of the bar.

The results as shown in Fig. 1 and the accompanying table needs little interpretation. The table of tensile strengths shows a striking superiority of the high-copper steel. The yield point and ultimate strength are in every case higher while the ductility is practically the same, although here too the average figures for reduction of area are with one exception slightly higher for the high-copper than for the low. This, however, is offset by slightly higher values for elongation in a majority of the tests in favor of the low-copper.

The hardness tests by both methods show the high-copper steel in all tests to be harder than the low-copper.

The Charpy shock tests show the high-copper steel in all cases to be superior to the low-copper.

In general, the results confirm the work of Ball,¹ Stead,² Breuil³ and Campbell⁴ as regards the effect of copper on hardness and tensile strength. They confirm the work of Breuil³ as regards brittleness and the work of Campbell⁴ as regards reduction of area. It is also true, that as Stead has stated, the behavior of the copper steel resembled that of nickel steel.

	Per Cent. Reduction		Per Cent. Elongation	
	High Cu	Low Cu	High Cu	Low Cu
Cooled in furnace.....	49.0	46.2	26.0	26.7
Cooled in air.....	52.7	52.7	27.3	27.3
Bars as forged.....	52.7	50.9	24.8	25.8
Drawn at 580° C.....	56.3	54.6	32.2	32.7
Drawn at 455° C.....	50.0	49.0	27.8	18.0
Drawn at 360° C.....	39.1	40.2	9.2	12.8
Quenched at 825° C.....	...	20.5	...	6.5

Acid-Proof Alloys.—An interesting investigation was recently recorded in *Metall und Erz* by ROLAND IRMANN, according to the *Chemical Trade Journal and Chemical Engineer*.

It is often asserted that electrolytic corrosion tests of voltaic couples of two metals should be a guide as to the corrosion of the alloys of those metals. The investigation by Dr. Roland Irmann of alloys of copper and nickel, to which tungsten and iron were further added, once more disproves this assumption. Much depends upon the proportions and the formation of compounds. Irmann (*Metall und Erz*) was in search of an alloy not to be attacked by strong hot sulphuric acid. He found that an alloy of nickel with 20 per cent of tungsten was much more resistant in this respect than nickel alone; but that the alloy was very difficult to machine and expensive. To introduce tungsten into the nickel, he started from copper-nickel. A voltaic couple of nickel and copper gave an electromotive force of 0.55 volt, which soon went down to 0.25 volt; nickel was dissolved, the copper becoming polarized with hydrogen. Failing to find a more satisfactory binary nickel-couple, he introduced other elements, especially tungsten, into the nickel-copper alloys, studying also the alloys of

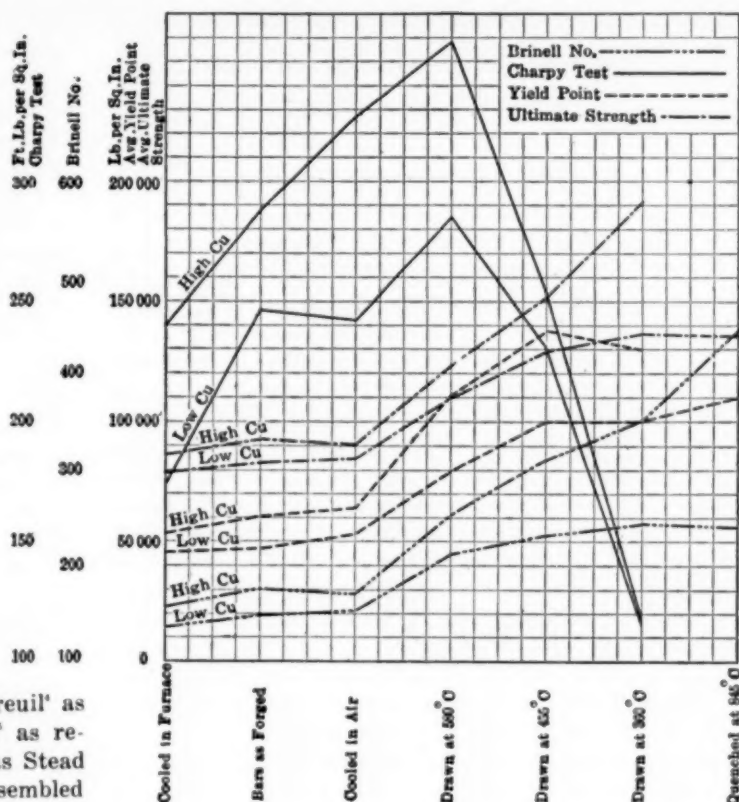


FIG. 1. RESULTS OF TESTS OF STEEL WITH DIFFERENT COPPER CONTENTS

copper and tungsten. He fused an alloy of nickel-tungsten in an arc furnace and added electrolytic copper; later he used a Helberger furnace, afterward adding more nickel as required. The alloy, consisting of 47 per cent of copper and 4.98 per cent of tungsten, proved highly resistant, and, at the same time, mechanically very strong, giving also the greatest elongation of these copper-tungsten alloys. The electric resistance was greater than that of constantan. Very good results were also obtained with ternary nickel-tungsten-copper alloys. The interesting point is, however, that quaternary alloys, further containing iron, proved far superior to the ternary alloys. This is important in so far, of course, as one may, in preparing the alloys, start from ferro-tungsten instead of having to isolate the tungsten first. By varying the percentage of iron—always low—the qualities of the alloys were suitably modified. When the sulphuric acid is to be used in the cold only, one should take alloys relatively rich in copper and also, to a minor degree, in tungsten and iron. For hot concentrated sulphuric acid Irmann recommends a nickel alloy with 43.65 per cent of Cu, 3.9 per cent W, 1.87 per cent Fe. This alloy also has a very high electric resistance and strength, and can easily be machined; the tensile strength was 28 tons per square inch, and rose to 35.05 tons per square inch in an alloy containing 3.9 per cent of iron. Some of the alloys, however, rather tended to separate in layers during fusion. Irmann also tried to improve German silver (60 per cent Cu, 20 per cent Ni, 20 per cent Zn) by the introduction of tungsten. But the tungsten would not alloy with the zinc, and he could not get more than 0.4 per cent of tungsten into this ternary alloy; the quaternary alloy was, moreover, badly attacked by sulphuric acid.

¹E. J. Ball and A. Wingham: On the Influence of Copper on the Tensile Strength of Steel. *Journal of the Iron and Steel Institute* (1889), I, 123-131.

²J. E. Stead and J. Evans: Influence of Copper on Steel Rails and Plates. *Journal of the Iron and Steel Institute* (1901), I, 89-100.

³P. Breuil: Copper Steels. *Journal of the Iron and Steel Institute* (1907), II, 1-78.

⁴Manufacture and Properties of Structural Steel, N. Y., Scientific Pub. Co., 1896.

Recent Metallurgical and Chemical Patents

Roasting and Sintering Apparatus

Combined Sintering and Smelting.—ARTHUR S. DWIGHT of New York City patents a process of sintering and smelting ore which consists of the formation of a continuous sinter cake on the well-known Dwight-Lloyd machine, and continually moving the cake through a slot into a furnace set immediately alongside. By submerging the inner end of the sinter cake into the contained bath its tendency to break by its own weight is counteracted. As the cake enters the furnace it slides between suitable electrical contacts. A sufficient voltage is impressed on the system so that electric current passes through the sinter cake, slag, metal, and furnace bottom to the opposite terminal. The cake is thus heated in four ways: By the heat of sintering, by the current passing through the cake, by conduction and radiation from furnace and contents, and by the arc at the end of the cake. The end of the advancing cake is thus continually melted off, metal, matte and slag separated, and withdrawn. (1,215,635, Feb. 13, 1917.)

Chloridizing Roast for Spent Pyrite.—EDGAR R. SUTCLIFFE of Leigh, England, patents a method for treating ores or residues of especial application to the process of converting copper contained in spent pyrite into cupric chloride for subsequent extraction by wet methods. The ore, together with sufficient common salt, is introduced into a cylindrical kiln *a* through a hopper *f*, and heated to a temperature of 600 to 700 deg. C. by a gas

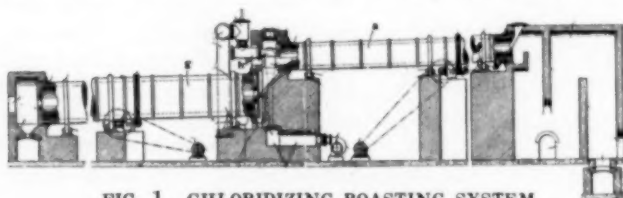


FIG. 1. CHLORIDIZING ROASTING SYSTEM

flame maintained at the nozzle *h*, at the lower end. Passage of the first kiln requires but a short time (from 30 to 40 minutes), during which the greater part of the metal to be recovered is chloridized. The heated mixture is discharged directly into the larger kiln *g*, where the same reaction is continued for a much longer time (3 to 8 hours), during which time elevated temperature and continuous agitation is maintained. This allows the final discharge to be almost completely converted. (1,245,634, Nov. 6, 1917.)

Sintering Blast Furnace Flue Dust.—A. J. BOYNTON of Lorain and A. E. SANDS of Akron, Ohio, have patented an improved method of sintering fines in pans having porous hearths. The usual process involves placing a layer of fines on a layer of crushed refractory protecting the grate bars. An igniter is then put into position above the pan, and an exhaust fan connected to the air box under the grate bars draws the products of combustion down through the mass of fines until the upper surface is burning. The igniter is then removed, the fan continues to draw air through the mass, thus gradually extending the combustion and agglomeration down through the entire mass. The results depend

upon close control of the amount of combustible present in the fines, too much carbon resulting in the formation of liquid cinder which trickles down, plugging the interstices in grate bars and porous hearth, superheating the cake and apparatus, and causing non-uniform results. It is therefore necessary to consume much time in cooling the mass, thus delaying operation to such an extent that as much time is required to sinter the last 10 per cent of the material as is necessary for the first 90 per cent.

In the operation of the improved process the mixed and moistened material is spread on the porous hearth and ignited as usual. After combustion has proceeded until a hard crust has formed on top, the pan is rotated 90 deg. about air-exhaust trunnions at the ends until the top surface is nearly vertical. The exhaust fan is kept running continuously, until sintering is completed; any cinder or slag which may liquidate out will trickle downward, now parallel to the porous hearth, and may be topped off by punching holes in the lower part of the cake. At the end of the process, the pan is further rotated, dropping the hot contents into a car beneath. (1,245,183, Nov. 6, 1917.)

Blast Roaster With Reciprocating Grates.—A. H. DERN of Salt Lake City and T. P. HOLT of Silver City, Utah (assignors to Holt-Christensen Process Co.), have

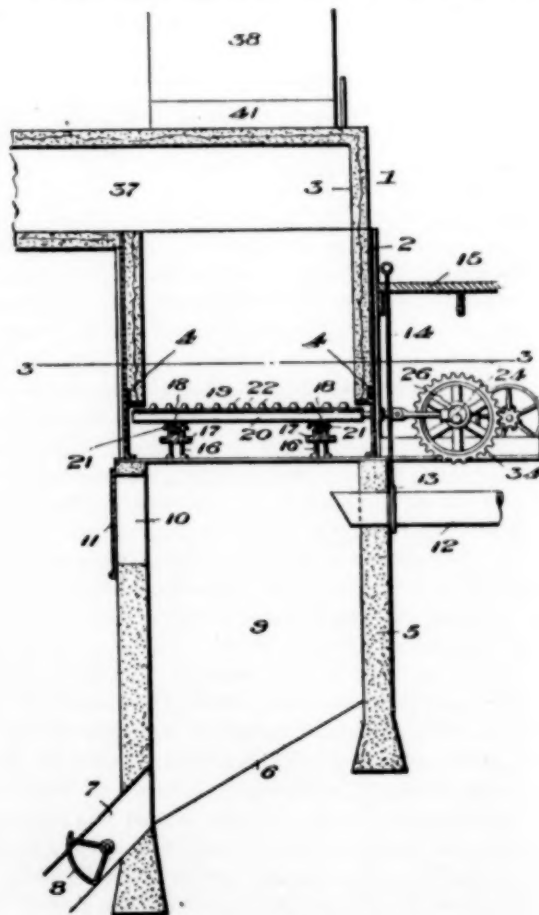


FIG. 2. HOLT-DERN BLAST ROASTER

patented improvements to ore roasters previously covered in Patents No. 1,113,961 and 2, Oct. 20, 1914. To afford a satisfactory draft without undue dust losses during charging, an inclosed rectangular roasting chamber communicates with a crosswise smoke flue (37).

and is charged through openings in the top. The grate is composed of a series of sections each made of a pair of longitudinal beams with crosswise teeth (22) at intervals on top. These may be driven independently by suitable mechanism (26) so that if the columnar roast settles more slowly in one part than in another, the first supporting grates may be operated a greater length of time. The body of the roaster rests directly upon a discharge bin (9), where the hot mass may remain for any desired period of time, which slow cooling is of advantage in chloridizing many ores. Air blast is introduced below the grates through the pipe (12), and the roasting is carried on in the manner described in the former patents. (1,251,189, Dec. 25, 1917.)

Metal Testing

Metal Sheet Testing.—The patent on the "Erichsen" metal sheet-testing machine, issued April 21, 1914 (No. 1,094,319) to ABRAHAM M. ERICHSEN of Christiania, Norway, has been reissued under date of Jan. 8, 1918 (No. 14,421). The machine was described in METALLURGICAL & CHEMICAL ENGINEERING for Dec. 15, 1916, p. 709.

Electric Furnaces

Two-phase Arc Furnace.—C. H. VOM BAUR of Douglaston, N. Y., has patented a two-phase arc furnace of the form illustrated in Fig. 3. Since in the two-phase, three-wire arrangement shown the central electrode carries $\sqrt{2}$ times the current in the lateral ones, the center of the furnace will be hotter, thus aiding in smelting down a fresh pile of ore and increasing the circulation in the molten bath. The side walls are dimensioned as shown so that overheating is avoided, all points receive approximately equal radiation. All electrodes are adjustable vertically; in addition

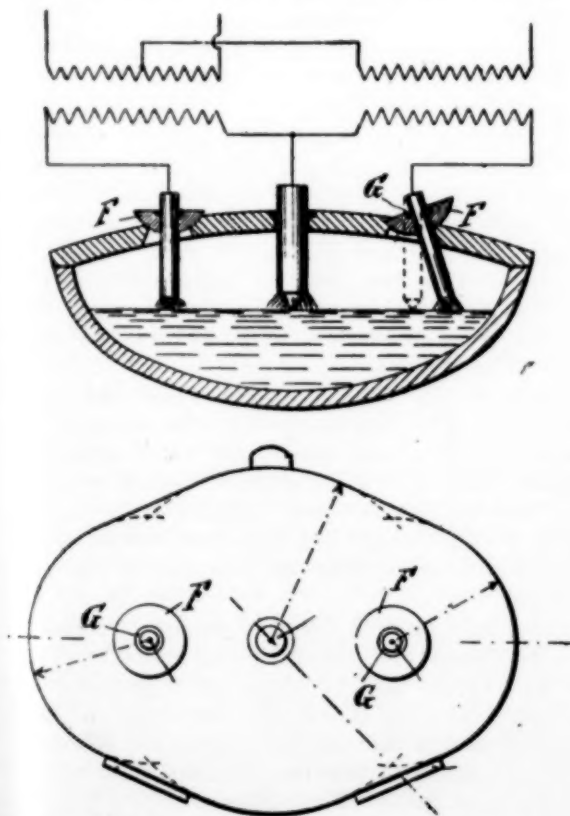


FIG. 3. PLAN AND ELEVATION OF TWO-PHASE ARC FURNACE

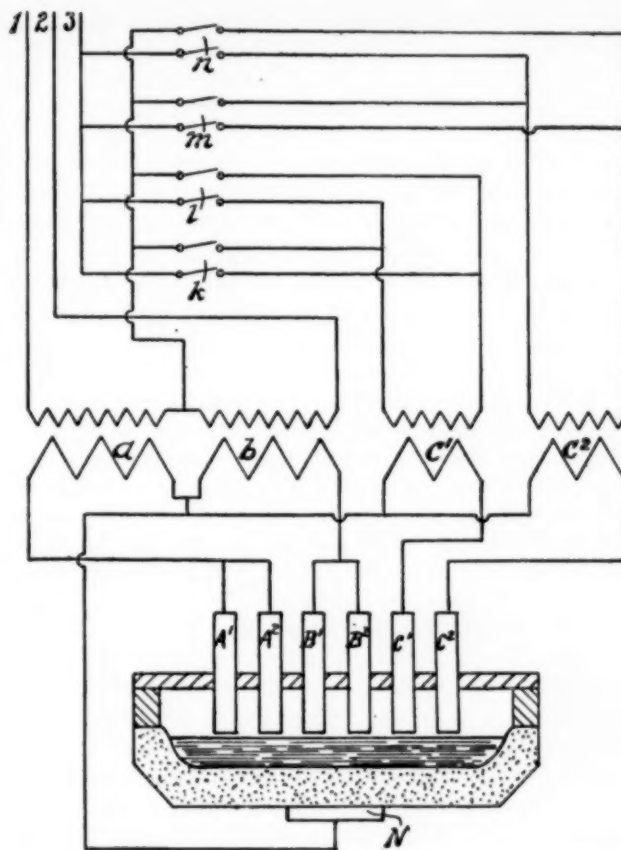
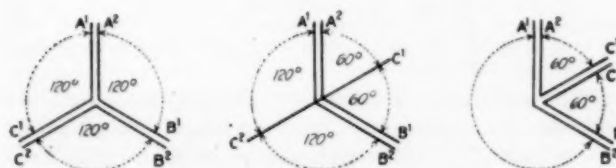


FIG. 4. WIRING DIAGRAM FOR HEAT CONTROL

tion the lateral electrodes, by means of spherical plug *F* and asbestos gaskets *G*, may be pointed toward any cold spot at the sides of the furnace. Flaming arcs are not desired, as being detrimental to the side walls and roof. The large area of slag-metal interface is of advantage in steel refining, and it is also claimed that the electrode arrangement gives a more steady current, fewer surges on the supply system and more uniform heat than a four-electrode, two-phase layout. (1,252,633; Jan. 8, 1918.)

Polyphase Arc Furnaces.—J. L. DIXON of Detroit, Mich., points out that advantages would accrue to the operation of arc furnaces from an electric system whereby heat could be generated either by the flaming arc, or by conduction through the melt at the will of the operator, and without an unequal loading of the supply system. He illustrates a number of wiring diagrams whereby adjustable electrodes are connected to polyphase current supply, with a lower terminal *N* connected to a neutral point, and switches in circuit to alter the phase relations of the transformers. For instance, in Fig. 4, with switches *k* and *m* closed and *l* and *n* open, the currents occupy the positions shown in Fig. 5, and the only current flowing to the hearth is due to the difference in the secondary voltages. To



FIGS. 5, 6 AND 7. VARIOUS POSITIONS OF CURRENT

throw a large current to the hearth, open *k* and *n* and close *l* and *m*; this reverses transformer *c'*, and the current is as in Fig. 6. Current as in Fig. 7 throws still larger currents to the hearth, and is had by reversing both transformers by changing the switches opposite to that of Fig. 5. In all cases the supply will not be unequally loaded provided each of the transformers *a* and *b* is supplying power equal to the total supplied by *c'* and *c''*. (1,241,351; Sept. 25, 1917.)

Manufacture of Sodium Ferro-cyanide.—ALEXANDER R. TILLINGHAST of Solvay, N. Y., patents improvements in the process of making sodium ferrocyanide, and assigns the patent to the Semet-Solvay Co.

Sodium ferrocyanide may be formed by effecting the combination with carbonate of iron and an alkali of hydrocyanic acid gas as obtained from the gases evolved in the destructive distillation of coal. A difficulty experienced in such a process is the loss of cyanogen due to the formation, with ammonia of the gas, of ammonium ferrocyanide. The object of the present process is to obviate such loss and provide other improvements.

The ammonia constituent of the gas is first removed by absorption in water, and the gas containing the cyanogen is then scrubbed with water containing ferrous carbonate, or its equivalent, ferrous hydrate, in suspension, and also soda ash in solution in sufficient quantity to insure the alkalinity of the carbonate.

The liquor from the scrubber contains sodium ferrocyanide, which is in solution, soda ash in solution, probably all of which exists as bicarbonate of soda, a large excess of ferrous sulphide in the form of a black, insoluble sludge, and a considerable quantity of insoluble ammonium ferro-ferrocyanide due to the presence of unseparated ammonia in the gas.

In order to convert this insoluble ferrocyanide, and any other insoluble ferrocyanide that may be present, to the soluble form, milk of lime is added to the mixture, which is then boiled and allowed to settle.

After the desired reactions are effected the insoluble residue is allowed to settle out and the clear liquid is drawn off and concentrated to the point of crystallization, after which it is run into pans and the ferrocyanide allowed to crystallize out. (1,252,741, Jan. 8, 1918.)

In another patent (1,252,742, Jan. 8, 1918) Mr. Tillinghast describes a further improvement in recovering the sodium ferrocyanide already in solution. This patent relates chiefly to the treatment of the mother liquor remaining after a portion of the ferrocyanide has been crystallized out. The claim follows:

"In the process of producing sodium ferrocyanide from the cyanogen content of gas, the method of recovering from a mother liquor from which sodium ferrocyanide has been crystallized the residue of sodium ferrocyanide and caustic soda and sodium carbonate contained therein which consists in treating ferrous sulphate with the mother liquor whereby the sodium ferrocyanide is converted into ferrous ferrocyanide and the caustic soda and sodium carbonate form ferrous hydrate and ferrous carbonate forming a suspension of the ferrous ferrocyanide, ferrous hydrate and ferrous carbonate in a solution of soda ash and scrubbing cyanogen containing gas therewith in a repetition of the process, and finally treating the resulting solution with milk of lime to convert the insoluble ferrous ferrocyanide into sodium ferrocyanide.

Ohio engineering societies, comprising local and sections of national societies, held a meeting at Columbus on Jan. 29 and formed the Association of Ohio Technical Societies. The object is to bring about professional unity.

The Parker Rust-Proofing Process

AN INTERESTING rust-proofing process has been recently developed by the Parker Rust-Proof Company of America, of Detroit.

The effect of the Parker process is essentially a chemical one. The operation consists in taking metal iron or steel, thoroughly cleaning it by sand blast, pickle, or, in some cases, a soda bath. After this the cleaned metal is immersed in a chemical solution, where it remains a predetermined length of time, depending upon the nature of the metal and just what effect is to be obtained. After the metal has been removed from the solution, it is oiled with a special oil. The oil fixes the effect of the immersion and gives it a black mat finish. On articles that are to be painted the oil is not put on, but the metal is left just as it comes from the chemical bath.

According to a patent issued to Walter I. Oeschger and assigned to the Parker Co. (1,254,263, Jan. 22, 1918), the bath consists of a 1½ per cent solution of acid meta-phosphate of tungsten, molybdenum or any of the metals of the third, fourth or fifth groups. (According to G. S. Newth's "Manual of Chemical Analysis").

The acid meta-phosphate of most general application is made by placing a quantity of iron oxide, preferably black iron scale (Fe_2O_3) in a pot with sufficient phosphoric acid to form a soft paste. The iron oxide is preferably powdered in advance. An amount of water equal to the acid is added to keep the mass from caking, after which heat is applied and the material is stirred until a dry granular mass is obtained, which is then powdered. If desired, heat may be applied to the oxide and acid before water is added. To obtain the phosphates of the other metals, their oxides or carbonates may be similarly treated. The patent states that the bath is preferably kept at the boiling point when the articles are being immersed.

It has been found that the mixing of about 2 per cent of strontium acid meta-phosphate with the iron compound above described gives a much more uniform and harder surface when high carbon steels are treated. Practically the same good result is attained by using the same percentage of molybdenum or tungsten acid meta-phosphates instead of the strontium acid meta-phosphate in combination with the iron compound.

According to another patent (1,254,624, Jan. 22, 1918) issued to the above and also assigned to the Parker Co., the same results may be obtained by first heating the iron or steel articles to about 600 deg. F., and then subjecting them to fumes made by heating the acid meta-phosphates to a sufficient temperature. In this case the articles may be treated right in the furnace.

The tanks used in the wet process are steel with special lining and steam-heating coils attached to the side of the tank. Such an arrangement causes a constant agitation throughout the solution. Experience has taught that the best results are obtainable by a tank built up in this way. Tanks of this type are necessary to rust-proof at a low cost.

The company states that all forms of iron or steel can be processed. The finest kind of dental needles are

being treated and in the same tank large structural steel pieces, many parts more than 20 ft. long. Machined parts, castings, pressings, forgings are all handled in a similar way and the effect of the process is likewise similar in all cases. Machined parts sometimes do not require cleaning, and they are immersed at once. Smaller parts are pickled or sandblasted in a tumbling barrel, which cuts down the cost of cleaning.

The natural finish resulting from the process is a steel gray, which, when oiled, becomes a soft mat black. The surface of the Parker processed metal is stated to be exceptionally well adapted for enameling, since there is a very fine microscopic etching which helps to bind the enamel. If at any time the enamel should crack and expose a part of the rust-proofed steel, there would be no rusting set in and consequently no peeling off of the enamel.

The rust-proofed metal does not withstand every test imaginable. For instance, it will not withstand acids such as hydrochloric, muriatic, acetic, sulphuric. Again, it will not stand up against constant attack from chemical fumes, although it resists intermittent attacks. It will prevent corrosion when exposed to atmospheric attack and also in a good many cases to other extreme tests where acids are not used. Sterilizing solutions do not affect the process.

The company is operating a plant in Detroit with a capacity of 200 tons of metal a day. Plans are under way for establishing similar plants in New York, Chicago, Philadelphia, Pittsburgh, Boston and St. Louis. Licenses are issued by the company to operate under the process. It is claimed by the company that the process is 90 per cent cheaper than the original method used in England.

American Clay for Graphite Crucibles

THE manufacture of plumbago crucibles has been greatly affected by the present war. The two important ingredients in these crucibles are graphite and plastic clay. Graphite being a lubricant, is difficult to bond and requires a clay of high plasticity and adhesiveness with a high drying and heat shrinkage.

As pointed out by Mr. McNaughton of the Joseph Dixon Crucible Co. last fall in his paper before the American Institute of Metals on the crucible situation, all of the clay for crucible purposes and 95 per cent of the plumbago was imported. The clay used came almost exclusively from Klingenberg, Germany. Shortly after the war started Germany prohibited the exportation of this clay, and while crucible manufacturers had about a year's normal supply on hand they found that the demand for crucibles was rapidly increasing and their supply would last them a much shorter time.

The crucible makers hence warned their customers that the quality of crucibles made from domestic clays would be for some time an unknown quantity until sufficient service tests had been made.

Laboratories have been called upon for testing possible clays, and several clays which give promise have been found. It is usually two or three months, however, by the time a crucible is made, using this clay, and thoroughly tested out.

One interesting clay which has been produced is the so-called K-10 synthetic clay, developed at the Kraus Research Laboratories in New York and originally

marketed by Chevalier & Tully of Baltimore, Md., but now handled by the Johns-Manville Co., who plan to market it on a large scale.

This clay is produced by making extractions from various clays, etc., which are so combined as to produce a fine-grained, highly plastic refractory mass having excellent bonding power. The shape of the grains must be such that the clay when moistened and dried will have high mechanical strength. Modulus of rupture tests made on this and other clays follow:

	Modulus of Rupture Lb. per Sq. In.	
	Raw	Mixed with 80% Non-Plastic Material
K-10	552	518
Klingenberg	374	381
Mississippi	507	168
H. & W.	310	67
Illinois	156	212

The following qualities are considered requisite for a good crucible clay: plasticity, adhesiveness, raw strength, density at low temperature, chemical balance, resistance to metals in fusion, high melting point, high shrinkage on drying, high shrinkage on heating and low coefficient of expansion.

Personal

Messrs. JOHN ALLINGHAM and N. H. BEATON have opened offices at 523-525 Lissner Building, Los Angeles, as assayers and chemists under the firm name of Allingham & Beaton. They expect to specialize in flotation tests. Mr. Allingham has recently been connected with the Humboldt Smelter, Humboldt, Ariz., as metallurgist. Mr. Beaton is a mining engineer and operated for several years in Canada and Mexico. He is at present manager of the Mining Department of the California Commercial Service, Los Angeles.

Dr. SAMUEL AVERY, chancellor of the University of Nebraska since 1909, has gone to Washington to serve as assistant chairman of the chemistry committee of the National Research Council, affiliated with the Council of National Defense. Dr. M. T. Bogert is chairman of the committee.

Dr. F. E. CARRUTH, formerly connected with the chemical division of the North Carolina Experiment Station, has become associated with the Schaefer Alkaloid Works, Maywood, N. J.

Prof. G. H. CLEVINGER has resigned as research professor of metallurgy at Stanford University and is now engaged in directing co-operative experimental work which is being done by the United States Bureau of Mines, Netherlands East Indies Government, Research Corporation of New York and others.

Lieut. A. W. DAVISON has been transferred from Washington to Niagara Falls, N. Y., where he is supervising chemical plant construction and experimental operation at the Oldbury Electrochemical Company.

Lieut. ELLERY K. FILES of the Gas Defense Service has been transferred from Washington to be instructor at the National Army camp at Yaphank, L. I.

Prof. D. M. FOLSOM of the department of mineralogy of Stanford University has been appointed by Mark L. Requa to be fuel oil administrator for the western states. His jurisdiction will cover Idaho, Montana, Utah, Arizona, New Mexico, Nevada, Oregon, Washington, California and Alaska.

Mr. PAUL W. FRYE, secretary and treasurer of the Laboratory Supply Company, Columbus, Ohio, has been made manager also, following the retirement from the company of Mr. Robert C. Schroth, Jr., former president and manager.

Mr. CLARENCE FULLER, manager of the Republic distillery at Curtis Bay, Md., has taken charge of the reopening of the distillery of Clark Brothers, Peoria, Ill., recently acquired, which will be devoted to the manufacture of denatured alcohol.

Dr. FRANK AUSTIN GOOCH, professor of chemistry and director of the Kent Chemical Laboratory of Yale University, will retire at the end of the present year. Professor Gooch will be succeeded by Professor Bertram Borden Boltwood, since 1910 professor of radiochemistry.

M. HENRI JEQUIER, metallurgist of the Société Minière et Metallurgique de Penarroya, and Dr. AUGUSTE HOLLARD, consulting engineer, are on a metallurgical visit to this country. The Penarroya company, which has its headquarters in Paris, and mines and works in Spain, is the largest smelter and refiner of lead in Europe.

Dr. YOGORO KATO, professor at the Tokyo College of Technology and Director of the Nakamura Chemical Research Institute in Tokyo, attended the recent annual meeting of the American Institute of Mining Engineers in New York. Dr. Kato expects to be in this country about two months on a professional visit.

Mr. H. W. KNOWLES of the New York office of the Cutler-Hammer Mfg. Co., has been transferred permanently to Washington for the period of the war. Mr. Knowles entered the service of the Cutler-Hammer Mfg. Co. shortly after graduating from Cornell University in 1912. He spent nearly five years in the shop, engineering department and sales department at Milwaukee. Since May of last year he has been connected with their New York district office, Hudson Terminal Building. The Washington Cutler-Hammer branch will have its headquarters at the Bradford, corner 18th and K streets, telephone Main 8426.

Mr. A. G. MCGREGOR of Warren, Ariz., and Mr. WILLIAM WRAITH, vice-president of the Andes Copper Mining Company, left New York City early in February for Chile, South America, where they will visit the site of the Andes Copper Mining Company's future reduction plants at Potrerillos. Mr. McGregor also expects to visit the smelter of the Cerro de Pasco Copper Corporation in Peru before his return to the United States, where he will supervise alterations and additions to their present equipment. Messrs. Wraith and McGregor expect to remain about three months.

Obituary

Mr. F. W. MATTHIESSEN, one of the pioneers in the zinc industry in this country, passed away at his home in La Salle, Ill., on Feb. 11. He was born in Germany in 1835 and was a graduate of the Freiberg School of Mines, where he formed his friendship with Edward C. Hegeler, both coming to this country together in 1856.

Their first enterprise in this country was an attempt to produce zinc from a silicate ore near Bethlehem, Pa. They were successful technically, but the company which had previously been working on it lacked funds to go on. They then went West to Missouri and made some successful experiments in smelting zinc ore, but political conditions interfered with commercial development, hence they went to Wisconsin and from there back to La Salle, Ill., where zinc smelting was definitely established by them. In 1871 the firm of Matthiessen & Hegeler was incorporated, and in 1881 a sulphuric acid plant was added. The firm became famous for its advanced metallurgical practice.

Mr. Matthiessen was for ten years mayor of La Salle and was a member of the American Institute of Mining Engineers. He was also principal owner of the Western Clock Co., makers of "Big Ben" clocks.

Mr. AUGUSTE MATHEZ, well-known mining engineer, passed away at his home in Denver, Col., on Feb. 4. Mr. Mathez was a graduate of the Columbia School of Mines and had extensive experience all over the world in the examination of properties, including China, Australia and South America. He was located for many years in Gilpin County, Colo., and was a well-known figure there.

Book Reviews

THE TECHNICAL ANALYSIS OF BRASS AND NON-FERROUS ALLOYS. By W. B. Price and R. K. Meade. Second Ed., 12 mo. (13 x 19 cm.), 376 pages, 25 cuts. Price, \$3.00. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Limited.

The introductory chapter on Engineering Alloys is fragmentary and contains some questionable statements. The rest of the book is good. Thirty pages are given to describing apparatus for electrolytic analysis. The determinations of aluminium, antimony, arsenic, bismuth, cadmium, copper, iron, lead, magnesium, manganese, nickel and cobalt, phosphorus, silicon, sulphur, tin and zinc are discussed thoroughly, while those of chromium, vanadium and titanium are considered when occurring in bronzes. A unique and valuable chapter concerns the analysis and control of plating solutions for deposition of brass, zinc, copper, silver, gold and nickel. It is an eminently useful and practical treatise, full of personal experiences and advice from the quite competent authors.

* * *

PRINCIPLES OF QUANTITATIVE ANALYSIS. By Walter C. Blasdale. Second Ed. Duodecimo (12 x 18 cm.), 402 pages, 70 cuts. Price, \$2.50 net. New York: D. Van Nostrand Company.

This is not the usual laboratory handbook, nor is it a mere copy of Ostwald's "Grundlagen der analytischen Chemie." It is an adaptation of the latter to the laboratory training of a professional analytical chemist. It is about one-quarter directions what to do and three-quarters explanation of the why and wherefore, as derived from the principles of physical chemistry. A limited number of analyses are described, usually rather briefly, and chosen rather for their suitability to illustrate principles than for their commercial importance. The book and its method are stamped strongly with the personality (and the personal views) of the author, and unquestionably his students, working under and with him while using the book, will get fine insight into quantitative analysis. Any other wide-awake instructor, using the book and supplementing it by copious drafts upon his own personal energy, will also achieve similar results.

* * *

THEORY AND CALCULATION OF ELECTRIC CIRCUITS. By Charles Proteus Steinmetz. 362 pages, with illustrations. Price, \$3.00. New York: McGraw-Hill Book Co., Inc.

This with its companion volume, "Theory and Calculations of Electrical Apparatus," may be considered as continuations, revisions or enlargements of his well-known book published about 20 years ago on "Theory and Calculation of Alternating Current Phenomena." To include the most necessary structural elements of our knowledge of electrical engineering the whole subject matter of the older volume is now issued in greatly enlarged form in the two present volumes and a third on "Alternating Current Phenomena," which together form a set of books which it will be well for all engineers of the advanced class to familiarize themselves with. Much of the present volume, being written in an easily understood style, is also of interest and of great value to those who have only an elementary knowledge of the science and application of electricity.

The author's masterly knowledge of the subject gives one confidence in his statement of facts, many of which are highly interesting; and his past and well-known success in the application of this knowledge to practice gives one confidence in his interesting opinions. One therefore feels safe to accept his unorthodox and somewhat novel classification and treatment of the subject. When the subject demands it the mathematical treatment is given, but involved mathematics is the exception rather than the rule.

From the standpoint of the electrochemist, of the 18 chapters parts of the first two on conduction are the most

interesting. His classification of conductors is based on the nature and properties of the conduction, and on this basis he classifies conductors under metallic, electrolytic, pyroelectric and electronic, thereby including such conduction as in the arc, in vacuum, discharges in gases, carbon, metallic silicon, boron, metallic oxides, magnetite, Nernst filaments, sulphides, silicates (glass), salts, etc. His own exhaustive researches with some of these conductors, like magnetite, tend to make his statements authoritative. By comparing the curves showing the relations between the volts and amperes he is enabled to make a better classification than when based on resistance alone.

The other sections are on magnetism, wave forms of currents, the instability of circuits, reactance, constant potential, constant current transforming, constant potential series operation, load balance of polyphase systems, circuits with distributed leakage, and oscillating currents, many of which subjects are often of interest also to the electrochemical engineer who has to deal with large quantities of electric power.

The high standing of the author as both an able scientist and a practical engineer, and the general recognition of his abilities, gives this book a stamp of authority; and his originality, logical reasoning, and independence of thought free from the bias of orthodoxy add interest to his books.

* * *

THEORY AND CALCULATIONS OF ELECTRICAL APPARATUS. By *Charles Proteus Steinmetz*. 480 pages, with illustrations. Price, \$4.00. New York: McGraw-Hill Book Co., Inc.

The relation of this volume to its companion on "Theory and Calculation of Electric Circuits" and to the author's former "Theory and Calculations of Alternating Current Phenomena" are explained in the review of the former, above, and need not be repeated here.

In the present volume the author discusses the most important characteristics of electrical apparatus including not only those in use but also many that may attain industrial importance with changes in industrial conditions. As an illustration he cites the time when small cheaply developed water powers will be united into one system, controlled from the central receiving station, in which case an entirely different type of generating station will have to be developed.

By "electrical apparatus" the author limits himself almost entirely to alternating-current motors though some space is devoted also to a.c. generators and to allied apparatus like rotary converters, frequency changers, rotary rectifiers, etc. With the exception of a short chapter on unipolar machines, and short references to several old types of series arc light machines, direct-current generators and motors are not included, and those that are briefly referred to are treated as alternating-current generators with rotary rectifiers. Nor is the ordinary static transformer included, except briefly as a special case of the rotary transformer. It would have been more explicit therefore to have limited the title to alternating-current rotary machines.

The treatment of the subject is directed to those who are already familiar with such machines and their characteristics and therefore supplements the more usual descriptive treatises. While the treatment in some cases is mathematical in character, by far the greater part of the book is descriptive and discursive text freely illustrated with many diagrammatic drawings and curves. While intended for the more advanced student and designer, there are many parts of the text which are instructive and interesting reading for those of lesser attainments also.

The recognized ability of the author and his long experience in the application of the higher scientific studies to the requirements of industrial practice, give the book an authoritative character.

To the electrochemist who is concerned with alternating-current machinery for power purposes the points of interest are the discussions of the characteristics, properties and behavior of such machinery, which will aid him in a better choice for specific conditions, as for instance when many small water powers are to be combined into one centrally controlled plant.

Current Market Reports

The Iron and Steel Market

The railroads had 15 days of extremely favorable weather, Feb. 6 to 20, inclusive, this being followed by weather only moderately favorable. As great progress as could possibly be expected has been made in clearing congestion on the roads, and a large quantity of loaded freight that was blocking yards and sidings has been moved forward to destination. Naturally the railroads addressed themselves to this task first, and not much has thus far occurred by way of returning empties, so that car supplies at blast furnaces and mills have increased very slightly, and shipments have been in corresponding proportion. As the major portion of the congestion has now been cleared, expectations are entertained that there will be a continued and important improvement in the supply of empties, with increasing shipments all along the line.

In 1917 such restriction in steel output as occurred was due to lack of pig iron, the restriction in pig iron being due to insufficient movement of coke and coking coal. While at times steel mill operations were interfered with by one influence or another, they were able to make up losses and produce as much steel as there was pig iron to make. In December the shortage of cars at steel mills became such that the mills were not able to ship as much as they were producing, and finished steel began to accumulate in considerable tonnage. In January this condition was accentuated, and stocks became such that production had to be curtailed to the rate at which steel could be shipped. From that time to date the governing restrictive influence has been the ability of the railroads to move steel. With the Garfield holidays, which closed steel mills and not blast furnaces, pig iron began to accumulate, and January as a whole showed a smaller proportion than normal of steel ingot production to pig iron production. Steel ingots were produced in January at the rate of about 28,600,000 tons per annum, pig iron production being at the rate of about 28,750,000 tons, whereas in 1917 the outputs had been approximately 42,200,000 tons of ingots and 38,600,000 tons of pig iron.

With the loosening up of traffic conditions in February a great deal of coke that was stalled en route was moved forward to blast furnaces, and even though shipments of coke did not increase materially many furnaces received a great deal more coke than was currently needed. Blast furnace operations underwent a sharp increase, whereas there was little increase in production of finished steel, and the result was a further accumulation of pig iron, also some accumulation of steel in intermediate forms, which may have reached considerable proportions.

Shipments of finished steel products in January averaged about 55 per cent of the mill capacity, which is fully 35,000,000 gross tons a year of finished rolled steel, nearly if not quite 3,000,000 tons a month, and February shipments have not been at much heavier rate, probably exceeding 60 per cent only slightly.

At the beginning of March, traditionally one of the two months of the year in which record outputs are made, the other, of course, being October, the iron and steel industry finds itself with improving traffic conditions, but still with no situation that can promise a record production. Physical conditions at the mills are, however, such that shipments can be increased as rapidly as the railroads furnish additional transportation, no matter how rapid that increase may be. There are large stocks of finished steel at mill awaiting shipment, and there is accumulated material all along the line, in the form of billets, ingots and pig iron.

The effect upon the market of any large increase in steel shipments is problematical. There is no assurance that ordinary commercial users of steel, not connected with the war, will be able to use steel in the greatly increased quantities that would be available if the mills were able to operate and ship at capacity. At an outside estimate the steel shipments since the first of the year have represented 60 per cent of the capacity, about two-thirds of this being war steel of all descriptions, including steel for the Government and for its Allies and steel for those who have contracts with these governments, not more than one-third being

ordinary commercial steel, entirely dissociated from the war. There are very few cases, indeed, in which the shipments of war steel have not been adequate. As a rule the steel mills have been able to supply war steel as rapidly as it could possibly be used. In many cases the shipments are not up to the original schedules compiled, but the utilization of this steel in shipyards, shell factories, etc., has likewise been behind schedule. In the circumstances it seems improbable that under the most favorable conditions there will be occasion to speed up the shipment of war steel by more than a small proportion, say from the recent proportion of 40 per cent of capacity to 50 per cent or possibly 55 per cent. At 100 per cent operation of the steel mills the supply of commercial steel would then be 45 or 50 per cent, against not over 20 per cent in the past two months. It is quite improbable that any such consumption of commercial steel could occur. Of course it is likewise improbable that the steel mills will be able to operate at 100 per cent in the near future, but it is interesting to put the problem in this way.

The comparison is particularly to the point in view of the fact that Washington is making a fresh effort to develop a system for the curtailment of unessential consumption of steel. Washington has addressed itself to this matter a number of times in the past, but after thinking of "pleasure automobiles" (which the automobile producers much prefer to call "passenger automobiles") has been unable to proceed farther. In the steel trade efforts to curtail artificially the unessential consumption of steel are regarded as unnecessary, for as a matter of fact many steel makers are concerned lest demand shall fall short of supply in the next few months. Undoubtedly steel is scarce, but the degree of scarcity is a slight one by comparison with the degree to which shipments of commercial or "unessential" steel have been reduced.

When on Dec. 29 it was announced by authority of the President that the set prices for iron and steel would be continued for revision by March 31, it was commonly thought that the Pomerene iron and steel price fixing bill would pass Congress, quite possibly by the end of January. The latest information is that no such bill will be pressed for the time being, if ever. Government price revision, therefore, if it comes at all, will be under the same principles as hitherto. The market shows distinct possibilities of declining under the set prices, as to some commodities at least, and it is quite possible that Washington may be disposed to let Nature take her course.

Chemical Market

COAL TAR PRODUCTS.—There was not a great deal of activity in this situation since the last writing, although trading in general was of improved tone. The delays entailed by chaotic shipping conditions continue to be a disturbing factor. Plants in some localities are also greatly hampered by the scarcity of coal. Several of the important items are scarce and prices are higher, which to an extent is due to the added requirements of the Government in the manufacture of necessities required in the prosecution of the war.

Benzol.—Slightly more business was closed on contract over the next few months, but there continues to be some hesitancy on the part of consumers to close over the entire year because of the uncertain price position.

Phenol.—There continues to be but small quantities offered, with prices slightly higher. The Government has contracted for the entire output of some producers.

Toluol.—There is practically none of this material available on the open market. From time to time a few drums are available, but the Government is releasing but little and only in case a real necessity is apparent.

Naphthalene has been more active of late than for some time heretofore. The demand has materially increased, but offerings are light, with prices higher.

Aniline Oil has been quiet, but prices are fairly firm, due to the scarcity of acids.

Beta Naphthol.—There is a fair volume of business passing in technical grade, but the other grades are not in heavy demand; prices are unchanged.

Benzaldehyde.—The toluol situation tends to restrict pro-

duction and higher prices are expected, with only a few producers offering.

Para Nitraniline.—A fairly active business is passing, but the production is heavy and prices are unchanged.

Benzoate of Soda.—There has been a decrease in the consuming demand, with prices slightly lower.

Saccharine continues weak, with offerings heavy, but it is slightly firmer than a few weeks ago.

Para Amido Phenol is slightly firmer, due to an increased demand, but it is possible to do a fairly low figure on material quantities.

H. Acid has not been particularly active of late, but the production is not heavy and prices are well maintained.

HEAVY CHEMICALS.—Trading in products under this classification during the past two weeks has been rather restricted except for special products in light supply and difficult to obtain. The export trade has been further hampered by the presidential proclamation placing all products on the embargo list and requiring licenses for foreign shipments. In addition all imports are now subject to Governmental supervision.

Caustic Soda.—Further declines have occurred in this product and in certain positions caustic has sold under the 5c. point. There has been practically no demand from consumers, the small amount of trading noted being for the account of dealers. January shipments from works were reported to have been small, notwithstanding the fact that cars have been loaded heavy; in some cases it is reported that cars have been loaded in excess of 80,000 lb. Consequently January bills of lading have commanded a premium since the first of the month. This has been the only position that has sold at a high figure. February-June has been available as low as 4.75c. A new production of some 500 tons monthly of ash and caustic is announced by a new company in Texas.

Soda Ash.—The market, in contrast to caustic, has held well and trading has been somewhat more active. Barrels have generally commanded substantial premiums, as seemingly export licenses are being granted. Dense ash is offered more liberally, but supplies are not abundant by any means. Generally ash at out-of-town points has been available on more favorable terms than at New York.

Bichromate of Soda.—This product has been more active than any of the heavy chemical items since we last reported. A pronounced scarcity of prompt material and a quiet but insistent demand has forced values skyward. However, the product is classified as one of a highly speculative character and the trade is rather inclined to remain away from it unless there is a genuine demand. Sales occurred at 25c. and 25½c. At the moment of writing the situation is a trifle easier.

Calcium Carbide.—The production is still much below the demand and sales are occurring at unthought-of prices. The demand from South America is still persistent, and sales of various sizes have been recorded at prices ranging from 12½c. to 15c., crated in drums. Some uncrated material has been sold at 12c. The Canadian producers have been quoting 8c. f.o.b., but no actual material has been available at the figure.

Zinc Oxide.—There is also a greater demand for this product than the producers can satisfy and considerable speculation is noted. The XX Horsehead brand has sold at prices ranging from 13c. to 15c. and even at these figures there is not a great deal of material available.

Sulphuric Acid.—The continued scarcity of tank cars has retarded the movement to a noticeable degree, and as a consequence acid has backed up upon the producers, with the result that the plants probably have more material on hand than they have had for many months. Of course the bulk of this is held for the account of the Government, but there have been numerous offers of 66-deg. brimstone acid in tanks at prices ranging from \$40 to \$45, f.o.b. works, according to amount and shipment. Considerable acid for export has sold at \$90, f.a.s. New York, drums included. Sixty-degree acid has been offered in the South at \$20 per ton, sellers' tanks, sellers' works, sellers' option.

Copper Sulphate.—Resale lots have been eliminated to a certain degree and this, coupled with a restricted production, has tended to increased firmness. Nichols brand has been offered rather sparingly and sellers have generally

held to 9½, less 1 per cent. Outside brands have been offered from 9c. to 9¼c.

Formaldehyde.—The difficulty in securing wood alcohol as a result of the Government assuming control of the industry has created a firmer tone and there is much bullish talk. Sales have occurred at prices ranging from 19¼c. up to 21c.

Glycerin.—After a prolonged period of inactivity there has been business passing in dynamite at prices ranging from 63½c. to 64½c. A number of cars of soap lye have changed hands at 46c. and 46½c., basis 80 per cent loose at New York. Offers in the West have been reported at lower figures, but owing to shipping difficulties have not found buyers.

Sodium Sulphide.—Lack of shipping facilities has retarded the movement and some spot lots have been available at lower prices. Shipments from works, however, have held well and the market is approximately 4c., f.o.b., for the 60/62 fused material.

Nitrite of Soda.—Spot lots have become rather scarce and sellers are now invariably holding for 35c. as a minimum trading level. The production has not been on a very elaborate scale of late and stocks are not abundant at any point.

Nitrate of Soda.—So far on account of the Government purchase of 100,000 tons of nitrate for direct distribution to the farmers two cargoes have arrived at southern points—one at Charleston and one at Savannah, totaling in all 13,000 tons. It is reported that the demand for this material has been much in excess of the amount available and the farmers have been eager purchasers at \$3.75 per 100 lb., f.o.b. cars, cash in advance. This situation has naturally tended to depress the outside market, and there has been very little nitrate moving. Importers have been quoting \$4.50 for prompt and future shipments at all ports, but resales have been reported at \$4.30 at various points.

Acetic Anhydride.—The production is being taken over by the Government for the purpose of impregnating airplane wings, with the result that there is very little material available on the open market. Production is confined to comparatively few sources as heretofore.

Carbonate of Potash.—Offers are seemingly confined to the Japanese material and sellers ask from 95c. to \$1.05.

Cellulose Acetate.—Production at the moment is confined to possibly four sources, and these makers are turning their entire product over to the airplane service of the army on the basis of \$4.50 for an 8-oz. bottle.

Prussiates.—Considerable activity has been noted in yellow prussiate of potash and some 10 tons changed hands at prices ranging from \$1.22½ to \$1.25. At the moment sellers hold to \$1.25 to \$1.27½. Prussiate of soda has been firm at prices ranging from 37½ to 38½.

Non-Ferrous Metal Market

Monday, Feb. 25.—The interesting features during the past two weeks were the advance in lead and the continued scarcity of tin. There is nothing new in copper and zinc.

Copper.—The Boston News Bureau states that the total production of fifteen large companies was less in January, 1918, than in January, 1917. This decrease is expected to continue for a short time, but during the latter part of the year substantial gains should be made. Copper prices remain the same, as fixed by the Government.

Tin.—There is hardly any spot market for tin, as none is for sale, but futures are being purchased to a considerable extent, with April Straits commanding 74½c., May 72 to 73c. and June 72 to 72½c. The situation as to shipments is no better, but American authorities are making every effort to have stocks released in London.

Lead.—The trust price of lead was advanced to 7.00c. on Feb. 11. Independents are asking 7¼c. The market is quiet.

Spelter.—There is nothing new. Prime Western is very dull at 7¼c. St. Louis and 7¼c. New York.

Tungsten.—Sales of wolframite have been made in considerable quantity at \$20.00 for future shipment of off grade material up to \$24.00 for high grade spot.

Manganese Ore.—There is a good demand and a premium

has been paid for foreign ore. The nominal quotation is \$1.20 per unit, basis 48 per cent.

Chrome.—High prices have been asked for high grade chrome ore, with the nominal quotation at 1.50 for 45 per cent material at the Pacific Coast.

OTHER METALS

Aluminium, lb.	36-38
Bismuth, lb.	2.50-2.75
Cadmium, lb.	1.50
Nickel, electrolytic, lb.	.55
Silver, oz.	.85%
Platinum, oz.	105.00
Palladium, oz.	135.00-137.00
Cobalt, lb.	3.25-3.50
Magnesium, lb.	2.00
Quicksilver, Cal.	120.00
Quicksilver, Mexican	115.00

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, FEB. 21, 1918

Acetic anhydride	lb.	1.35	—	1.50
Acetone, drums	lb.	Nominal		
Acid, acetic, 28 per cent.	lb.	.05½	—	.06
Acetic, 56 per cent.	lb.	.11½	—	.12
Acetic, glacial, 99½ per cent, carboys	lb.	.35	—	.36
Bitric, crystals	lb.	.13½	—	.14½
Citric, crystals	lb.	.75	—	.78
Hydrochloric, C. P.	lb.	.08	—	.09
Hydrochloric, 20 deg.	lb.	.02½	—	.03
Hydrochloric, conc., 22 deg.	lb.	.03	—	.03½
Hydrofluoric, 30 per cent, in barrels	lb.	.06	—	.06½
Lactic, 44 per cent.	lb.	.15	—	.15½
Lactic, 22 per cent.	lb.	.05½	—	.06½
Nitric, 36 deg.	lb.	Nominal		
Nitric, 42 deg.	lb.	.09½	—	.09½
Oxalic, crystals	lb.	.45½	—	.46½
Phosphoric, 47-50 per cent crude	lb.	.07½	—	.08
Phosphoric, ref. 50 per cent	lb.	.26	—	
Picric	lb.	Nominal		
Pyrogallol, resublimed	lb.	3.15	—	3.25
Sulphuric, 60 deg.	ton	40.00	—	35.00
Sulphuric, 66 deg.	ton	75.00	—	45.00
Sulphuric, oleum (Fuming), tank cars	ton	1.30	—	80.00
Tannic, U. S. P., bulk	lb.	.75	—	1.35
Tartaric, crystals	lb.	.75	—	.78
Tungstic, per lb. of W	lb.	1.80	—	1.90
Alcohol, sugar cane, 188 proof	gal.	4.90	—	
Alcohol, wood, 95 per cent.	gal.	1.35	—	1.38
Alcohol, denatured, 180 proof	gal.	.70	—	.72
Alum, ammonia lump	lb.	.04	—	.04½
Alum, chrome ammonium	lb.	.18½	—	.19
Alum, chrome potassium	lb.	.20½	—	.22
Alum, chrome sodium	lb.	.12½	—	.13
Alum, potash lump	lb.	.09	—	.09½
Aluminium sulphate, technical	lb.	.01½	—	.02½
Aluminium sulphate, iron free	lb.	.02½	—	.03½
Ammonia aqua, 26 deg. carboys	lb.	.20	—	.21
Ammonia, anhydrous	lb.	.40	—	.43
Ammonium carbonate	lb.	.11	—	.12
Ammonium nitrate	lb.	(Fixed price)		
Ammonium, sulphate domestic	lb.	.07½	—	.07½
Amyl acetate	gal.	5.00	—	5.25
Arsenic, white	lb.	.16½	—	.18½
Arsenic, red	lb.	.65	—	.70
Barium carbonate, 99 per cent.	ton	80.00	—	90.00
Barium carbonate, 97-98 per cent.	ton	65.00	—	67.00
Barium chloride	ton	65.00	—	85.00
Barium sulphate (Blanc Fixe, powder)	lb.	.03½	—	.04
Barium nitrate	lb.	.08½	—	.08½
Barium peroxide, basis 70 per cent.	lb.	.30	—	.32
Bleaching powder, 35 per cent chlorine	lb.	.02½	—	.02½
Borax, crystals, sacks	lb.	.07½	—	.08½
Bromine, crude	ton	Nominal		
Bromine, technical	lb.	.75	—	
Calcium, acetate, crude	lb.	Nominal		
Calcium, carbide	lb.	.14½	—	.14½
Calcium chloride, 70-75 per cent, fused, lump	ton	21.00	—	22.00
Calcium peroxide	lb.	1.60	—	1.70
Calcium phosphate	lb.	.34	—	.35
Calcium sulphate 98-99 per cent	lb.	.09	—	.09½
Carbon bisulphide	lb.	.07½	—	.08
Carbon tetrachloride, drums	lb.	.15½	—	.16
Carbonyl chloride (phosgene)	lb.		—	
Caustic potash, 88-92 per cent.	lb.	.84	—	.85
Caustic soda, 76 per cent.	lb.	.05	—	.05½
Chlorine, liquid	lb.	.15	—	.18
Cobalt oxide	lb.	1.60	—	1.65
Copperas	lb.	.01½	—	.01½
Copper carbonate	lb.	.45	—	
Copper cyanide	lb.	.75	—	.78
Copper sulphate, 99 per cent, large crystals	lb.	.09	—	.09½
Cream of tartar, crystals	lb.	.59	—	.61
Epsom salt, bags	lb.	.03	—	.03½
Formaldehyde, 40 per cent.	lb.	.19½	—	.20
Glauber's salt	100 lb.	1.00	—	1.10
Glycerine, bulk, C. P.	lb.	.63½	—	.64½
Iodine, resublimed	lb.	4.25	—	4.35
Iron oxide	lb.	.13	—	.15
Lead, acetate, white crystals	lb.	.15	—	.18
Lead arsenate (Paste)	lb.	.15	—	.18
Lead nitrate	lb.	.15	—	.16
Litharge, American	lb.	.09½	—	.11½
Lithium carbonate	lb.	1.50	—	2.00
Manganese dioxide, U. S. P.	lb.	.70	—	.75
Magnesium carbonate, technical	lb.	.10½	—	.11
Nickel salt, single	lb.	.14	—	.15
Nickel salt, double	lb.	.12	—	.14
Phosgene, see Carbonyl chloride	lb.		—	
Phosphorus, red	lb.	1.35	—	1.40
Phosphorus, yellow	lb.	1.50	—	1.60
Potassium bichromate	lb.	.48	—	.50
Potassium bromide granular	lb.	1.35	—	1.50
Potassium carbonate calcined, 85-90 per cent.	lb.	.95	—	1.05

Potassium chlorate, crystals.....lb.	.41	—	.42
Potassium cyanide, 98-99 per cent.....lb.	2.50	—	2.75
Potassium iodide.....lb.	3.75	—	3.80
Potassium muriate 80-85 p. c. basis of 80 p. c.....ton	340.00	—	350.00
Potassium nitrate.....lb.	.27	—	.31
Potassium permanganate (U. S. P.).....lb.	4.00	—	4.10
Potassium prussiate, red.....lb.	2.90	—	3.00
Potassium prussiate, yellow.....lb.	1.28	—	1.30
Potassium sulphate, 90-95 p. c. basis 90 p. c.....ton	Nominal	—	
Rochelle salts.....lb.	.30	—	.39½
Salammoniac, gray gran.....lb.	.15½	—	.17
Salammoniac, white gran.....lb.	.15	—	.16
Sal soda.....100 lb.	1.25	—	1.30
Salt cake.....ton	25.00	—	26.00
Silver cyanide, based on market price of silver.....oz.	.57½	—	.58
Silver nitrate.....oz.	2.90	—	3.05
Soda ash, 58 per cent, light, flat.....100 lb.	3.60	—	4.00
Soda ash, 58 per cent, dense, flat.....100 lb.	.16½	—	.17
Sodium acetate.....lb.	.02½	—	.03
Sodium bicarbonate, domestic.....lb.	.23½	—	.24
Sodium bicarbonate, English.....lb.	.08	—	.10
Sodium bichromate.....lb.	.24	—	.25
Sodium bisulphite, powd.....lb.	.40	—	.41
Sodium chlorate.....lb.	.17	—	.18
Sodium fluoride, commercial.....lb.	.02½	—	
Sodium hypsulphite.....lb.	2.50	—	
Sodium molybdate, per lb. of Mo.....100 lb.	4.50	—	4.60
Sodium nitrate, 95%.....lb.	.35	—	.36
Sodium nitrite.....lb.	.45	—	.50
Sodium peroxide.....lb.	.04	—	.04½
Sodium phosphate.....lb.	.37	—	.40
Sodium prussiate, yellow.....lb.	.03½	—	.04½
Sodium silicate, liquid (60 deg.).....lb.	.02½	—	.03
Sodium sulphide, 30 per cent, crystals.....lb.	.05	—	.05½
Sodium sulphide, 60 per cent., fused.....lb.	.05	—	.06
Sodium sulphite.....lb.	.25	—	.35
Strontium nitrate.....lb.	.06	—	.06½
Sulphur chloride, drums.....lb.	.15	—	.40
Sulphur dioxide, liquid, in cylinders.....100 lb.	3.85	—	4.40
Sulphur, flowers, sublimed.....100 lb.	3.70	—	3.85
Sulphur, roll.....ton	35.00	—	37.50
Sulphur, crude.....lb.	Nominal	—	
Tin bichloride, 50 deg.....lb.	.75	—	.90
Tin oxide.....lb.	.25	—	.30
Zinc carbonate.....lb.	.10½	—	.11
Zinc chloride.....lb.	Nominal	—	
Zinc cyanide.....lb.	.14	—	.16
Zinc dust, 350 mesh.....lb.	.13	—	.14
Zinc oxide, American process XX.....lb.	.06	—	.07
Zinc sulphate.....lb.		—	

Coal Tar Products (Crude)

Benzol, pure, water white.....gal.	.35	—	.40
Benzol, 90 per cent.....gal.	Nominal	—	
Toluol, pure, water white.....gal.	.35	—	.50
Xylol, pure, water white.....gal.	.17	—	.22
Solvent naphtha, water white.....gal.	.13	—	.16
Solvent naphtha, crude, heavy.....gal.	.33	—	.35
Creosote oil, 25 per cent.....gal.	.29	—	.30
Dip oil, 20 per cent.....gal.	8.00	—	20.00
Pitch, various grades.....ton	1.05	—	1.10
Carbolic acid, crude, 95-97 per cent.....lb.	.60	—	.65
Carbolic acid, crude, 50 per cent.....lb.	.35	—	.38
Carbolic acid, crude, 25 per cent.....lb.	.18	—	.20
Cresol, U. S. P.....lb.		—	

Intermediates, Etc.

Alpha naphthol, crude.....lb.	1.00	—	1.25
Alpha naphthol, distilled.....lb.	1.60	—	2.00
Alpha naphthylamine.....lb.	.58	—	.60
Aniline oil, drums extra.....lb.	.27	—	.28
Aniline salts.....lb.	.32	—	.34
Anthracene, 80 per cent.....lb.	.50	—	.65
Benzaldehyde (f.f.s.).....lb.	4.50	—	5.50
Benzidine, base.....lb.	1.75	—	1.85
Benzidine, sulphate.....lb.	1.40	—	1.60
Benzoic acid U. S. P.....lb.	5.50	—	5.75
Benzoate of Soda, U. S. P.....lb.	4.50	—	4.75
Benzyl chloride.....lb.	2.25	—	2.50
Beta naphthol benzoate.....lb.	10.00	—	12.00
Beta naphthol, sublimed.....lb.	.85	—	.90
Beta naphthylamine, sublimed.....lb.	2.65	—	
Dichlor benzol.....lb.	.12	—	.18
Diethylaniline.....lb.	4.00	—	5.00
Dinitro benzol.....lb.	.35	—	.40
Dinitrochlorbenzol.....lb.	.40	—	.42
Dinitronaphthalene.....lb.	.55	—	.60
Dinitrotoluol.....lb.	.55	—	.60
Dinitrophenol.....lb.	.50	—	.55
Dimethylaniline.....lb.	.63	—	.65
Diphenylamine.....lb.	1.00	—	1.10
H-acid.....lb.	2.25	—	2.50
Metaphenylenediamine.....lb.	1.85	—	2.00
Monochlorbenzol.....lb.	.19	—	.22
Naphthalene, flake.....lb.	.10½	—	.11
Naphthalene, balls.....lb.	.12	—	.14
Naphthionic acid, crude.....lb.	1.40	—	1.50
Naphthylamin-di-sulphonic acid.....lb.	1.00	—	1.10
Nitro naphthalene.....lb.	.45	—	.50
Nitro toluol.....lb.	.60	—	.55
Ortho-amidophenol.....lb.		—	
Ortho-dichlor-benzol.....lb.	.15	—	.18
Ortho-toluidine.....lb.	1.00	—	1.20
Ortho-nitro-toluol.....lb.	.75	—	1.00
Para-amidophenol, base.....lb.	3.50	—	4.00
Para-amido-phenol, H. Ch.....lb.	4.00	—	5.00
Para-dichlor-benzol.....lb.	.12	—	.15
Paranitraniline.....lb.	1.05	—	1.15
Para-nitro-toluol.....lb.	1.50	—	1.60
Paraphenylenediamine.....lb.	3.00	—	3.50
Para-toluidine.....lb.	2.25	—	2.50
Phthalic acid anhydride.....lb.	4.50	—	5.00
Phenol, U. S. P.....lb.	.53½	—	.55
Resorcin, technical.....lb.	6.00	—	7.00
Resorcin, pure.....lb.	9.00	—	10.00
Salicylic acid.....lb.	1.00	—	1.10
Salol.....lb.	1.85	—	2.00
Sulphanilic acid, crude.....lb.	.82	—	.85
Tolidin.....lb.	2.50	—	
Toluidine-mixture.....lb.	.75	—	.85

Petroleum Oils

Crude (at the Wells)

Pennsylvania.....bbl.	4.00	—	
Corning, Ohio.....bbl.	2.85	—	
Somerset, Ky.....bbl.	2.60	—	
Waco, Ohio.....bbl.	2.38	—	
Indiana.....bbl.	2.08	—	
Illinois.....bbl.	2.22	—	
Oklahoma and Kansas.....bbl.	2.00	—	
Caddo, La., light.....bbl.	2.00	—	
Corsicana, Tex., light.....bbl.	2.00	—	
California.....bbl.	.98	—	1.32
Gulf Coast.....bbl.	1.00	—	

Fuel Oil

New York.....gal.	.11	—	
Pittsburgh.....gal.	.07½	—	.10
Oklahoma-Kans.....bbl.	1.50	—	2.35
Texas.....bbl.	1.50	—	1.90
Los Angeles.....bbl.	1.52	—	
San Francisco.....bbl.	1.45	—	

Gasoline (Wholesale)

New York.....gal.	.24	—	
Boston.....gal.	.25	—	
Pittsburgh.....gal.	.26	—	
Chicago.....gal.	.21	—	
Oklahoma.....gal.	.25	—	
San Francisco.....gal.	.20	—	

Lubricants

Black, reduced, 29 gravity, 25-30 cold test.....gal.	.19	—	.20
Cylinder, light.....gal.	.34	—	.35
Cylinder, dark.....gal.	.33	—	.34
Paraffine, high viscosity.....gal.	.36	—	.37
Paraffine, 903 sp. gr.....gal.	.29	—	.30
Paraffine, .865 sp. gr.....gal.	.21	—	.22

Flotation Oils

(Prices at New York unless otherwise stated)

Pine oil, crude, f.o.b. Florida.....gal.	.44	—	
Pine oil, steam distilled, sp. gr. 0.925-0.940.....gal.	.53	—	
Pine oil, destructively distilled.....gal.	.49	—	.53
Pine-tar oil, sp. gr. 1.025-1.035.....gal.	.35	—	
Pine-tar oil, double refined, sp. gr. 0.965-0.990.....gal.	.40	—	
Pine oil, light, sp. gr. 0.950, tank cars, f.o.b. works.....gal.	.37	—	
Pine oil, heavy, sp. gr. 1.025, tank cars, f.o.b. works.....gal.	.26	—	
Pine tar, thin, sp. gr. 1.060-1.080.....gal.	.30	—	
Turpentine, crude, sp. gr. 0.980-1.000.....gal.	.40	—	
Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.990.....gal.	.19	—	
Hardwood oil, f.o.b. Michigan, sp. gr. 1.06-1.08.....gal.	.19	—	
Wood creosote, ref. f.o.b. Florida.....gal.	.31	—	

Vegetable and Other Oils

China wood oil.....lb.	.20½	—	.21
Cottonseed oil, crude.....lb.	.17½	—	.18
Linseed oil, raw, cars.....gal.	1.30	—	1.32
Peanut oil, crude.....gal.	1.37	—	
Rosin oil, first run.....gal.	.35	—	
Rosin oil, fourth run.....gal.	.66	—	
Soya bean oil, Manchuria.....lb.	.18½	—	.19
Turpentine, spirits.....gal.	.47½	—	

Miscellaneous Materials

Barytes, floated, white, foreign.....ton	40.00	—	50.00
Barytes, floated, white, domestic.....ton	30.00	—	36.00
Beeswax, white, pure.....lb.	.56	—	.64
Casoin.....lb.	.22	—	.30
Chalk, light, precipitated, English.....lb.		—	
Feldspar.....ton	8.00	—	12.00
Fuller's earth, powdered.....100 lb.	1.00	—	1.50
Osokerite, crude, brown.....lb.	.65	—	.75
Osokerite, American, refined, white.....lb.	.75	—	1.00
Red lead, dry, carloads.....lb.	.10	—	.11½
Rosin, 280 lb.....bbl.	7.00	—	
Soapstone.....ton	10.00	—	12.50
Talc, American, white.....ton	15.00	—	22.00
White lead, dry.....lb.	.09	—	.10

Refractories, Etc.

(F.O.B. Works)

Chrome brick.....net ton		Nominal	
Chrome cement, Grecian.....net ton		Nominal	
Clay brick, 1st quality fireclay.....per 1000	50.00	—	55.00
Clay brick, second quality.....per 1000	35.00	—	40.00
Magnesite, raw.....ton	30.00	—	35.00
Magnesite, calcined.....ton	35.00	—	36.00
Magnesite, Grecian, dead burned.....net ton	85.00	—	90.00
Magnesia brick, Grecian, 9x4½x2½.....net ton	135.00	—	140.00
Silica brick.....per 1000	50.00	—	60.00

Ferroalloys

Ferrocobalt, 15-18 per cent, carloads, f.o.b. Niagara Falls, N. Y.....ton	160.00	—	
Ferrocobalt.....lb.	18.00	—	
Ferrocobalt, per lb. of Cr.....lb.	.50	—	
Ferromanganese, domestic.....ton	250.00	—	
Ferromanganese, English.....ton	325.00	—	
Ferromolybdenum, per lb. of Mo.....lb.	5.00	—	
Ferrosilicon, 75 per cent, f.o.b. N. Y.....ton		—	
Ferrosilicon, 50 per cent, carloads, del., Pittsburgh.....ton	165.00	—	175.00
Ferrosilicon, 50 per cent, contract.....ton	100.00	—	175.00
Ferrotungsten, 75-85 per cent, f.o.b. Pittsburgh.....lb.	2.35	—	2.45
Ferrosilicon, f.o.b. works, per lb. of U.....lb.	7.00	—	
Ferrovandium, f.o.b. works.....lb.	4.00	—	5.00

Ores and Semi-finished Products

Antimony ore, per unit.....unit	1.60	—	1.75
Chrome ore, 48 per cent minimum, f.o.b. Cal., per unit ton.....ton	1.50	—	
Manganese ore, 48 per cent and over, per unit.....ton	1.20	—	
Manganese ore, chemical.....ton	80.00	—	100.00
Molybdenite, per lb. of MoS ₂lb.	2.15	—	
Tungsten, Scheelite, per unit of WO ₃ton		—	
Tungsten, Wolframite, per unit of WO ₃ton	24.00	—	
Uranium oxide, 96%.....lb.	3.25	—	3.60
Vanadium pentoxide, 99%.....lb.	10.50	—	
Pyrites, foreign.....unit	.17	—	.17½
Pyrites, domestic.....unit	.28	—	.30

INDUSTRIAL

Financial, Construction and Manufacturers' News

New Companies

THE AMERICAN ALLOY & CHEMICAL CORPORATION, Los Angeles, Cal. Capital, \$1,000,000. To manufacture chemicals and allied specialties. Incorporators: J. L. Boyle, G. A. Green, G. H. Beesemeyer, F. L. Riley, B. J. Quinn, and J. L. Stevens.

THE ANACONDA LEAD & ZINC COMPANY, Dover, Del. Capital, \$100,000. To engage in a general mining and milling of lead and zinc. Incorporators: L. B. Phillips, and J. B. Bailey, Dover.

THE ATLAS DRAWN STEEL CORPORATION, Dunkirk, N. Y. Active capital, \$275,000. To manufacture various drawn steel products. Incorporators: A. H. Hunter, A. F. Dohn, and H. E. Webster, Buffalo.

THE AURORA SILVER MINES CORPORATION, New York. Capital, \$1,000,000. To engage in a general mining business. Incorporators: S. B. Howard, George V. Reilly, and A. W. Britton, 65 Cedar Street.

THE BANKERS LEAD & ZINC COMPANY, Oklahoma City, Okla. Capital, \$250,000. To mine for lead and zinc. Incorporators: G. A. Morris, W. A. McAtee, and H. E. Brouillard, Wapanucka, Okla.

THE BEST MINING COMPANY, Shawnee, Okla. Capital, \$200,000. To mine for lead and zinc. Incorporators: S. H. Lester, M. J. McLaughlin, and H. B. Callahan.

THE BONE-DRY LIME CORPORATION, Jamestown, N. Y. Capital, \$100,000. To manufacture commercial fertilizer, etc. Incorporators: C. Lamberton, Franklin, Pa.; J. C. Dick, Utica; and A. Davis, Jamestown, N. Y.

THE BUCKNER PROCESS COMPANY, Worcester, Mass. Capital, \$20,000. To manufacture chemicals, petroleum products, and allied specialties. Harry L. Buckner, Wollaston, is the principal incorporator.

A. M. CASTEL & COMPANY, Dover, Del. Capital, \$1,500,000. To manufacture tools and iron and steel products.

THE CHLORINE PRODUCTS COMPANY, New York. Capital, \$100,000. To manufacture chemicals and kindred specialties. Incorporators: S. B. Howard, G. V. Reilly, and A. W. Britton, 65 Cedar Street.

THE CLAREMONT PAPER COMPANY, Bel-lows Falls, Vt. Capital, \$1,500,000. To manufacture paper, etc. Incorporators: J. N. Harvey, Harold E. Whitney and H. C. Fenton, Brattleboro.

THE CLARK COUNTY OIL & GAS COMPANY, Montgomery, Ala. Capital, \$100,000. To manufacture gas and produce and refine oil. Incorporators: J. C. McCarquada, F. H. Grande, and C. T. McCarquada.

THE CRESCENT COLOR & CHEMICAL WORKS, Plainfield, N. J. Capital, \$25,000. To manufacture colors and chemicals, etc. Incorporators: A. and J. and Walter Alexander, all of New York.

THE CRESCENT LEAD & ZINC COMPANY, Miami, Okla. Capital, \$250,000. To operate lead and zinc properties. Incorporators: J. A. Utterback, O. E. and W. A. Doty, Newkirk.

THE D-B-L PRODUCTS CORPORATION, New York. Capital, \$150,000. To manufacture celluloid products. Incorporators: A. W. Burke, C. H. Louis, and I. L. Ernst, 151 West Eighty-sixth Street.

THE DIAMOND CHEMICAL COMPANY, Utica, N. Y. Nominal capital, \$7,000. To manufacture chemicals. Incorporators: F. A. Hill and H. J. Willett, Utica.

THE ELLSWORTH MINING COMPANY, Miami, Okla. Capital, \$150,000. To engage in a general lead and zinc mining business. Incorporators: Lloyd Weber, J. Wise Brown, Tulsa, and A. B. Ellsworth, Joplin, Mo.

THE FLORENCE PIPE FOUNDRY & MACHINE COMPANY, Philadelphia, Pa. Capital, \$1,000,000. To operate a foundry and engage in the manufacture of special machinery. Incorporators: Charles R. Wood, Spencer P. Hazard, Edwin J. Lane, Philadelphia; Thomas L. Morton, Palmyra, N. J.

THE FORGE PRODUCTS CORPORATION, New York. Capital, \$160,000. To manufacture high speed steel products. Incorporators: A. E. Moore, F. H. Butcher, and A. F. McCabe.

THE FOUR STATES MINING COMPANY, Idaho, Okla. Capital, \$50,000. To mine for lead and zinc. D. B. Strawn is the principal incorporator.

THE GALCONDA MINING COMPANY, Ardmore, Okla. Capital, \$15,000. To mine for lead and zinc. Incorporators: John M. Imrie, E. E. Chivers, and O. C. Lasher.

THE GIVEN MINING COMPANY, Athens, Ga. Capital, \$64,000. To mine for gold. Incorporators: E. L. A. J. Haughey, and Theodore Brough, Athens.

R. H. GREEFF & COMPANY, New York. Capital, \$200,000. To manufacture chemicals and allied products. Incorporators: W. N. Barnum, F. E. Dixon, and R. H. Greeff, New York.

THE GREENFIELD LEAD & ZINC COMPANY, Greenfield, Okla. To mine for lead and zinc. Incorporators: J. E. Ross, J. C. Collier, and J. W. Baker, Greenfield.

THE HANCOCK FOUNDRY & MACHINE COMPANY, New Cumberland, W. Va. Capital, \$25,000. To operate a local steel plant.

THE INTERNATIONAL IRON & STEEL COMPANY, Augusta, Me. Capital, \$250,000. To manufacture iron and steel products. E. M. Leavitt, Augusta, is president and treasurer.

THE INTO CHEMICAL COMPANY, Reno, Nev. Capital, \$1,000,000. To manufacture chemicals and chemical compounds. Incorporators: H. W. Carr, Saginaw, Mich.; J. N. Morris, and W. M. Gardner, Reno.

JENNINGS & COMPANY, Boston, Mass. Capital, \$90,000. To manufacture dye-stuffs, etc. Incorporators: F. W. Bourne, Waldo Farrar, and C. W. Jennings, Boston.

THE KNOX DRAWN STEEL COMPANY, Pittsburgh, Pa. Nominal capital, \$5,000. To manufacture drawn steel products. J. G. Bassett is the principal incorporator.

LAWLESS BROTHERS PAPER MILLS, Rochester, N. Y. Capital, \$150,000. To manufacture paper and paper products. Incorporators: M. D., M. J. and D. J. Lawless, Rochester.

H. S. LENT, INC., New York. Capital, \$25,000. To manufacture cordage and twine from hemp fibre, etc. Incorporators: W. Coenen, F. E. Fehr, and R. S. Strahan, 44 West Ninth Street.

THE LIBERTY STEEL & FOUNDRIES COMPANY, New York. Capital, \$1,500,000. To manufacture iron and steel products, etc.

THE LORANE MINING & ROYALTY COMPANY, Miami, Okla. Capital, \$40,000. To mine for lead and zinc. Incorporators: Ray Thompson, C. C. Moses, J. T. Dewberry and J. T. Gephart.

THE LYON SOAP PRODUCTS COMPANY, New York. Capital, \$25,000. To manufacture soaps and soap products. Incorporators: A. DeGobi, J. E. McCullough, and L. S. Furman, 356 East Twelfth Street.

THE MANUFACTURERS PRODUCTS COMPANY, New York. Capital, \$100,000. To manufacture chemicals, leather product, etc. Incorporators: H. C. Neuberger, H. Buntingham, and C. M. Chapman, 2 Rector Street.

THE MOGUL MINING COMPANY, Oklahoma City, Okla. Capital, \$250,000. To mine for lead and zinc. Incorporators: F. E. Sheets, T. F. Tate, and W. L. Buck.

THE MONTANA CHROME MINING COMPANY, Philadelphia, Pa. Capital, \$1,000,000. To engage in a general mining business. Incorporators: F. R. Hansell, Philadelphia; J. V. Pimm and S. C. Seymour, Camden, N. J.

THE MORE PRODUCTS COMPANY, Los Angeles, Cal. Capital, \$10,000. To manufacture fertilizers from kelp, etc. Incorporators: Frank Martin, George Cunningham, Z. Jones, and E. W. Tunsgate, Los Angeles, and H. M. Henning, Santa Barbara.

THE NEW HAVEN IRON & STEEL COMPANY, New Haven Conn. Nominal capital, \$9,000. To manufacture iron and steel products. Incorporators: William Alderman, Charles Merberg, M. A. and A. N. Alderman, New Haven.

THE NOEQUA CHEMICAL COMPANY, Philadelphia, Pa. Capital, \$450,000. To engage

in the manufacture of chemicals and allied products.

THE ORETON COMPANY, Wilmington, Del. Capital, \$100,000. To manufacture iron and steel products.

THE ORGANIC PRODUCTS & COLOR COMPANY, Elizabeth, N. J. Capital, \$50,000. To engage in the manufacture of dye-stuffs and allied products. Incorporators: Hugo Helburn, Seymour M. Hermann, New York; and Charles B. Rasenberger, Brooklyn.

THE PARKER TIRE & RUBBER COMPANY, Dover, Del. Capital, \$750,000. To manufacture automobile tires and other rubber goods. Incorporators: M. L. Harty and K. E. Longfield, Wilmington.

THE PEARSE ENGINEERING COMPANY, Ltd., Dover, Del. Capital, \$100,000. To engage as chemical engineers. Incorporators: J. G. Gray, M. B. F. Hawkins, S. S. Adams, Jr., Wilmington.

THE POLLOCK-BURT PAPER COMPANY, Dallas, Tex. Capital, \$10,000. To manufacture paper and paper products. Incorporators: Lawrence S. Pollock, S. Dreyfuss, and William J. Burt.

ASHMEAD F. PRINGLE, Inc., Charleston, S. C. Capital, \$200,000. To engage in the manufacture of fertilizers. Incorporators: A. F. E. H. Pringle, and Frank E. Barron, Charleston.

THE QUENEIDA GRAPHITE CORPORATION, Birmingham, Ala. Capital, \$3,000,000. To engage in the production of graphite. Incorporators: J. F. B. Baugh, Birmingham; J. D. Baker and J. P. Murray, Philadelphia, Pa.

RENAUD & COMPANY, Inc., New York. Capital, \$25,000. To engage in a general mining business. Incorporators: G. Renaud, J. S. Galland, and D. J. Dowling, 20 Stuyvesant Place, State Island.

THE SALICYLATE PRODUCTS MANUFACTURING COMPANY, Newark, N. J. Capital, \$25,000. To manufacture chemicals and allied products. Incorporators: A. C. Ullman, Charles D. Wagler and William P. Murphy, all of Newark.

THE SEMINOLE CHEMICAL COMPANY, New York. Capital, \$100,000. To manufacture chemicals. Incorporators: M. Suesskind and I. J. Joseph, 1421 Madison Avenue.

THE SEMINOLE VARNISH COMPANY, Tampa, Fla. Capital, \$500,000. To manufacture varnishes, etc. Incorporators: Gustave Tuschell, 144 Lafayette Street, Tampa.

THE SMITHVILLE ORE CONCENTRATING COMPANY, Inc., New York. Capital, \$70,000. To mine for ores of various kinds. Incorporators: K. L. Alexander, M. Anelli, and E. Powers, 15 Broad Street, New York.

LEOPOLD SONN & BROTHER, New York. Capital, \$30,000. To manufacture paper, paper boxes, and other paper specialties. Incorporators: S. H. and F. and L. Sonn, 132 Mulberry Street.

THE STEEL SPECIALTY CORPORATION, Pawtucket, R. I. Capital, \$100,000. To manufacture steel products. Incorporators: Fred A. Sweet, Walter A. Briggs and George E. Thurber.

THE TANTX LEATHER CORPORATION, Newark, N. J. Capital, \$100,000. To engage in the manufacture of leather, leather products, etc. Incorporators: Charles L. Mason, Harold Bouton and F. J. Israel, Newark.

THE UNION STEEL PRODUCTS COMPANY, New York. Capital, \$100,000. To engage in the manufacture of steel products. Incorporators: R. Tally, and I. and M. Gordon, 700 West One Hundred and Eightieth Street.

THE UNITED STATES AND BRAZIL EXPORT COMPANY, Inc., New York. Capital, \$10,000. To deal in chemicals and dyestuffs. Incorporators: James W. McGovern and Joseph Gambaro.

THE UNIVERSAL IRON PRODUCTS COMPANY, Wilmington, Del. Capital, \$1,200,000. To manufacture steel rails, iron bars, culverts, etc. Incorporators: M. Gehrman, William F. O'Keefe, and E. E. Wright, Wilmington.

THE VALLEY MINING COMPANY, Miami, Okla. Capital, \$150,000. To engage in a general mining business for the production of lead, zinc, etc. Incorporators: R. T. Price, J. A. Stokes, and H. Russell.

THE WESTERN MAGNESIA PRODUCTS CORPORATION, New York. Capital, \$10,000. To manufacture magnesia products. Incorporators: V. W. Thorpe, O. J. Helg and I. V. Weisdrob, 71 Broadway.

THE D. L. WILKOFF STEEL COMPANY, Pittsburgh, Pa. Capital, \$50,000. To manufacture steel products. H. T. Feinberg is the principal incorporator.

THE WILMINGTON SUGAR REFINING COMPANY, Dover, Del. Capital, \$15,000,000. To manufacture and refine sugar and molasses. Incorporators: Adolph and Earl Segal, and Thomas B. Hall, Philadelphia, Pa.

THE WOODBRIDGE CERAMIC CORPORATION, Woodbridge, N. J. Capital, \$30,000. To manufacture fire brick, etc. Incorporators: N. Peter Jensen, P. P. Svhendorf and William H. Prall, Woodbridge.

Construction and Operation

Alabama

ASHLAND.—The Crystalline Flake Graphite Company is making rapid progress in the construction of its new mill for the concentration of graphite and it is anticipated that operations will be inaugurated about March 15.

Arizona

BISBEE.—The Dos Cabezas Gold Ridge Mining Company, with properties in Cochise County, is planning for the immediate construction of a new mill to have a capacity of 100 tons. The company has been doing extensive development work at its mines, and it is estimated that the ore reserve is sufficient to supply the proposed new mill for about ten years.

PEARCE.—The Middlemarch Mining Company, about seven miles west of Pearce, has completed the construction of a new flotation plant, and will inaugurate operations at an early date.

PRESCOTT.—Plans are being considered by the Consolidated Arizona Smelting Company for the immediate enlargement of its smelter, the plant, when completed, to have a capacity of 2,500,000 pounds of copper per month.

PRESCOTT.—The Lacey Pabst Gold Mines Company has completed the installation of new electrical equipment at its properties, and is planning for the immediate construction of a new mill to have a capacity of 100 tons daily.

SAN XAVIER.—The Mineral Hill Consolidated Mining Company is planning for extensive development work at its properties in the San Xavier district, Pima County. The main shaft has been sunk to a depth of 500 feet, the ore that is being blocked out assaying 4 per cent copper. A new duplex electrical pump, capable of handling 250 gallons per minute is now being placed, the power to be supplied by a 75-horsepower semi-Diesel Y-type engine and 50-kw. generator.

Arkansas

CONWAY.—Fire, on February 10, originating in the lint room of the plant of the Conway Cotton Oil & Gin Company, caused a loss of approximately \$20,000.

FORT SMITH.—The Fort Smith Smelter Company, which is now operating three blocks of its four-block smelter at South Fort Smith, is planning to place the fourth block of the plant in operation at an early date.

LITTLE ROCK.—The Southern Paint Manufacturing Company, manufacturer of a special roofing paint, is planning for the removal of its plant and offices from Camden to Little Rock. The company controls extensive lignite mines at Corcoran Spur, and through a special retorting process, produces a high grade carbon from the lignite, which carbon is used as a base for the company's roofing paint, iron paint and darker colored house paints.

California

FRESNO.—The California Products Company has awarded a contract for the construction of a new reinforced-concrete drier at its plant, which was recently destroyed by fire. The new drier is estimated to cost \$60,000. The company is contemplating the construction of a new acid plant, concrete storage towers, and new elevator system. The Cahill-Vensano Company, San Francisco, is the contractor.

LOS ANGELES.—The Chemical Production Company is making rapid progress in the construction of a large new plant at Owens Lake, to be devoted to the manufacture of soda ash.

LOS ANGELES.—The Stauffer Chemical Company, manufacturer of chemicals and kindred products, is building a new plant on a site comprising about fifteen acres, recently acquired, to be devoted to the production of hydrochloric acid. The new works are estimated to cost about \$100,000.

LOS ANGELES.—The Western Calcium Chloride Syndicate has completed the equipment of a large new plant for the manufacture of calcium chloride.

SAN DIEGO.—The Steele Packing Company is considering the lease of a large site on the tidelands at the foot of Jupiter street, to provide for the construction of a large fish packing and reduction plant. The entire works are estimated to cost about \$70,000.

RANDESBURG.—The Yellow Aster Mining Company has commenced the operation of its old mill, which has been idle for some time, pending the completion of the new plant now in course of construction. Development work at the mine has uncovered ore buried by the great slide of 1914, and in the new plant, which will be double the capacity of the former, the coarse product will be eliminated by screening, and the fine ore, containing practically all the gold, will be fed directly into the stamps. Plans are under consideration by the company for the mining of its large bodies of low-grade ore by steam shovels or a cable-way excavator, and is considering the installation of a set of ball-mills to replace the stamp mill.

SAN FRANCISCO.—Fire recently partially destroyed the plant of the Eagle Tanning Company, Vermont street and San Bruno avenue, with loss estimated at \$50,000.

PORTOLA.—The Anaconda Copper Company is said to have completed arrangements for taking over the interest of the Plumas Copper Company in the Walker Mine, about 25 miles from Portola, for a consideration of \$500,000. For the past few months the mine has been developed under the direction of the International Copper Company, and concentrate from the flotation plant has been shipped to the Tooele smelter. The flotation plant has a daily capacity of 160 tons.

WASHINGTON.—The Washington Asbestos Company is planning to inaugurate operations in its mill at an early date. The company has been developing its asbestos claims all through the winter.

AUBURN.—The Pacific Coast Mines Company has recently acquired title to the Dutch, Sweeney, and App mines, and is preparing plans for extensive development work. The company is considering the immediate construction of a large new mill to have a capacity of about 700 tons daily. Experiments have also been perfected for a special treatment for the sulphide ore.

YERINGTON.—The Kennedy Copper Company is planning extensive development work at its mines in the Buckskin Mountain, near Yerington, and is considering plans for the construction of a new flotation plant in the early spring.

Colorado

EUREKA.—Rapid progress is being made by the Sunnyside Mines Company in the construction of a new crusher plant and 500-ton flotation works at its mines.

PUEBLO.—The Colorado Fuel & Iron Company is planning to inaugurate operations at an early date in its new by-product coke ovens at the Minnequa works, now in course of construction. The plant consists of two batteries of sixty ovens each, designed for sixteen-hour coke, to have a capacity of approximately 70,000 tons of coal a month, with a coke production of 46,000 tons. The new plant, which will comprise the ovens, benzol works, coal washer, and other structures is being erected by the H. Koppers Company, Pittsburgh, Pa., and is estimated to cost about \$4,000,000.

DENVER.—Plans have been perfected for the organization of the American Mineral Oil Company, which has acquired about 1400 acres of shale fields and is planning for the construction of a large plant for the production of oil. H. M. Roeschlaub, Denver, heads the company.

Connecticut

STAMFORD.—The American Synthetic Color Company has filed plans for the construction of its proposed new two-story brick and concrete addition, about 30x130 feet, on Sunnyside avenue. Contract has been awarded to Harold A. Parsons, Bank street, Stamford, at a price of \$12,000.

Delaware

WILMINGTON.—The E. I. du Pont de Nemours Company has awarded a contract for the construction of a new plant for the manufacture of powder and high explosives at Sattes, W. Va., to cost about \$10,000,000. The Thompson-Starrett Company, 49 Wall street, New York, is the contractor. It is said that the company has

made arrangements with the War Department for the erection of two plants at Charleston, W. Va., and Nashville, Tenn., respectively, to have a capacity of about 1,000,000 pounds of smokeless powder daily, combined.

WILMINGTON.—The Ball Grain Powder Company, recently incorporated, will build a new one-story shell-loading plant at Miller road and Thirty-second street. Plans for the structure have been prepared.

WILMINGTON.—Fire on February 16, at the local recovery plant of the du Pont Powder Company, seriously damaged one of the buildings.

WILMINGTON.—The plant of the Baldt Steel Company, which is engaged on work for the Government, was damaged to the extent of about \$150,000 by fire, on February 16.

Georgia

ATLANTA.—Fire, on February 12, partially destroyed the plant of the Southern Chemical Products Company, following an explosion.

Idaho

WALLACE.—Rapid progress is being made by the Spokane Metals Recovery Company in the construction of a new 200-ton plant on Nine Mile Creek, about three miles from Wallace, and it is expected to inaugurate operations at an early date. The equipment includes a flotation system and tables, the water of the creek and its mineral content being conveyed to the plant by a 500-foot flume. C. L. Hewett is president and manager of the company.

Illinois

CHICAGO.—The American Tractor Company, South Michigan avenue, will build a new tractor plant at Peoria, to include two foundry buildings, assembling works, machine shop, main manufacturing building, power plant, and auxiliary structure. Plans for the work are being prepared. The entire plant is estimated to cost about \$150,000.

CHICAGO.—The Twin Tube & Rubber Company, South Michigan avenue, has filed plans for the construction of a new one-story and basement works. Contract for the structure, which will be about 40x40 feet, has been awarded.

CHICAGO.—The Indian Refining Company has recently acquired property on Western avenue, between the right of way of the Atchison, Topeka & Santa Fe Railroad and the Illinois and Michigan Canal, for a consideration of about \$20,000, as a site for the construction of a new compounding and distributing plant.

GALENA.—The Blewett Mining Company, recently incorporated with a capital of \$100,000, is planning for extensive development work on its zinc ore properties about half a mile from Galena. Work has been started on a new shaft, and the company is considering plans for the immediate construction of a mill building.

Indiana

WHITING.—The Sinclair Oil Company is making favorable progress in the construction of its new local refinery. The company has made announcement that the laying of a pipe line from the mid-continent field to Whiting has been practically completed. This pipe line has been in course of construction for about two years, and is the second of its kind to cross the Mississippi River, the Standard Oil Company having laid the first one.

GREENCASTLE.—The Indiana Portland Cement Company is having plans prepared for a new cement works to cost about \$1,000,000. The plant will include a main manufacturing building, cement mill, machine shop, and auxiliary structures. Adam Beck is president.

INDIANA HARBOR.—Plans have been filed and contract awarded by the Standard Forgings Company for the construction of a new addition to its plant to cost about \$15,000.

Iowa

MUSCATINE.—Plans are being prepared by the Continental Serum Company for the construction of a new plant to replace its laboratories recently destroyed by fire. The new works will be located on the site of the former plant in Park Place, and are estimated to cost \$50,000. Dr. S. E. Houk is head of the company.

OAKVILLE.—The Hall Air Lock Company has completed arrangements for the leasing of a large foundry building at Granville, Ill., for the manufacture of its products.

Kansas

FREDONIA.—The Fredonia Oil & Gas Company, the Sunshine Oil & Gas Company and other large oil interests, are said to be considering a site in Fredonia for the location of a large new oil refinery.

Maryland

BALTIMORE.—The Continental Can Company, Keyser Building, has had plans prepared for the construction of a new two-story addition, about 35x100 feet, to its works at Orangeville.

BALTIMORE.—Plans are being prepared by the H. E. Crook Company, Inc., Light street, for the reconstruction of its ship-building plant at Locust Point recently partially destroyed by fire with loss estimated at \$50,000. Howard E. Crook is president.

HAVRE DE GRACE.—The Atlas Powder Company has awarded a contract to the Ley Construction Company, Pittsburgh, Pa., for the erection of a large new chemical manufacturing plant, comprising from thirty-five to forty concrete buildings, including power house, administration buildings and manufacturing units, together with housing and trucking facilities. The entire works are estimated to cost approximately \$5,000,000.

LUKE.—The West Virginia Pulp & Paper Company has completed plans and specifications for the proposed new plant which it will erect for the Government to be devoted to the manufacture of industrial alcohol and other chemicals from pulp and paper mill waste. The new works are estimated to cost about \$3,000,000.

Massachusetts

CAMBRIDGE.—Fire recently partially destroyed the plant of the American Hard Rubber Company, Potter, Pinney and Ninth streets, with loss estimated at \$30,000.

FITCHBURG.—The core department and main foundry building of the Fitchburg Foundry Company were recently damaged by fire, with loss estimated at about \$5000. M. J. Perault is manager.

BOSTON.—The works of the Plant Leather Company, 113-17 North street, were recently partially destroyed by fire, with loss estimated at approximately \$30,000. The company was engaged on Government contracts.

Michigan

GRAND RAPIDS.—The St. Paul Pioneer Press & Dispatch Company is making rapid progress in extensive improvements in its local paper manufacturing plant, to increase the capacity by approximately 40 per cent. Included in the work is the construction of a new power house, the installation of new generating and manufacturing devices and a new 750 horsepower electric generator. Improvements have been made in the grinder room, and a new cylindrical barker has been installed.

SAGINAW.—The Northwestern Glass Company is planning to inaugurate operations in its new local plant about March 15. About 200 hands will be employed for initial operations. W. G. Edmonds is secretary and treasurer.

Minnesota

MINNEAPOLIS.—The Minneapolis Steel & Machinery Company has taken out a building permit for the construction of a new factory building at East Twenty-ninth street and Snelling avenue, to cost about \$28,000.

Mississippi

LAUREL.—The plant of the Laurel Oil & Fertilizer Company was partially destroyed by fire recently with loss estimated at about \$55,000. It is said the damaged sections will be immediately rebuilt.

Missouri

ST. LOUIS.—The American Manufacturing Company, 1026 South Eleventh street, has had plans prepared for the construction of a new one-story brick and concrete machine shop, about 60x70 feet, at its works at East St. Louis, Ill., to cost about \$30,000.

ST. LOUIS.—Fire recently damaged buildings Nos. 9 and 13 at the plant of the Mallinckrodt Chemical Works, manufacturers of chemicals and allied products.

ST. LOUIS.—The St. Louis Malleable Castings Company, Conduit avenue, is considering the construction of a new plant to cost about \$50,000.

Montana

HAMILTON.—The Ravalli County Sugar Company, which was recently organized to take over the interests of the Montana-Utah Sugar Company, has postponed the construction of its proposed new sugar factory which is estimated to cost about \$750,000, due to the scarcity of labor and materials in this section. V. L. Arnold is local manager.

Nevada

ROCHESTER.—The United States Smelting, Refining & Mining Company has completed arrangements for the taking over and operation of the mines of the Nenzel Crown Point Mining Company. The United States company is planning for the construction of a new mill at the properties and extensive development work.

TONOPAH.—The Belmont Wagner Mining Company is making rapid progress in the construction of a new 300-ton mill at its mines, and it is anticipated that the new plant will be in operation by March 15.

New Jersey

JERSEY CITY.—The George H. Segal Company, 139 Logan street, manufacturer of chemicals, is planning for the reconstruction of its plant recently destroyed by fire.

JERSEY CITY.—The Zibell Damp Resisting Paint Company, 273 Water street, New York, has acquired local property consisting of six city lots on Culver avenue and four lots adjoining on Fisk street, as a site for the construction of a large new plant.

HOBOKEN.—Robert Mayer & Company, Clinton street, manufacturer lithographic inks, etc., has acquired the property of the Prana Carbonic Syphon Company, about 50x100 feet, at Eleventh and Adams streets, to be used as an extension to its works.

NEWARK.—The Verona Chemical Company, Verona and Riverside avenues, has taken out a building permit for the construction of a new one-story brick extension to its plant.

KEARNY.—The Blast Furnace Products Corporation, recently incorporated in Delaware, has acquired the plant formerly occupied by the New Jersey Zinc Company on the Hackensack River, adjoining the Newark Plank Road, Kearney, comprising about 12½ acres, for a consideration said to be about \$350,000. The property has a frontage of 930 feet on the river, and is about 915 feet deep, and it is said that the company will use it for the establishment of a new works.

RIDGEFIELD PARK.—The British-American Chemical Company, 52 Vanderbilt avenue, New York, is planning for the construction of new additions to its plant at the site of the Tennessee Copper Company, recently acquired.

PLAINFIELD.—The Niles-Bement-Pond Company, manufacturer of machine tools, is planning for the erection of two new plant buildings at its works to cost about \$40,000. The company is also having plans prepared for its proposed new plant on the Kearny meadows near Kearny, on property recently purchased. The works will consist of a group of one and two-story buildings, comprising machine shops, riveting works, erecting shops, etc., and will cost about \$2,000,000. The plant will be used for the manufacture of cranes industrial locomotives, and other specialties.

EDGEWOOD.—The United States Government has announced plans for the construction of a large plant for the manufacture of gas, to cost about \$35,000,000.

New Mexico

MOGOLLON.—The Socorro Mining & Milling Company is making rapid progress in the erection of its new mill, and it is anticipated that operations will be inaugurated around May 1.

New York

NEW YORK.—The Imperial Chemical Manufacturing Company, 135 West Twenty-third street, has leased property at 382 Lafayette street, to provide for increased capacity.

BROOKLYN.—Charles Pfizer & Company, 11 Bartlett street, manufacturers of chemicals, etc., have awarded a contract for alterations and improvements in its plant on Gerry street, near Harrison street, to cost \$15,000.

BROOKLYN.—The National Lead Company is having plans prepared for the con-

struction of a new five-story plant, about 95x210 feet, at Marshall, John and Gold streets. The new works are estimated to cost \$250,000.

MECHANICVILLE.—Contract has been awarded to the Fuller Construction Company, New York, for the erection of the proposed new plant for the Government to be constructed near the plant of the West Virginia Pulp & Paper Company. The new works will be devoted to the manufacture of acetone, which is used in connection with varnish for the coating of aeroplane wings.

LOCKPORT.—The Upson Company, manufacturer of wall board, has acquired the plant of the St. Clair Paper Company, Capac, Mich., and is planning to dismantle and remove adjacent to its local plant. The consideration was \$150,000. The addition will be used for the manufacture of a new fibre product, and will give employment to about 250 additional hands.

BUFFALO.—The Great American Chemical Company, manufacturer of chemicals and allied products, has taken out a building permit for the erection of a new factory building to be located at 284 South Park avenue, to cost about \$9000.

North Carolina

GASTONIA.—Fire recently destroyed a portion of the plant of the Rhyne Roller Mill Company, East Gastonia, with loss estimated at \$10,000.

LEXINGTON.—The Natural Chemical Products Company, recently incorporated with a capital of \$350,000, has completed arrangements for the development of about 500 acres of feldspar deposits in Mitchell County. Contracts have been awarded for the necessary mining machinery and for the chemical equipment for the extraction of potash from the feldspar rock.

RALEIGH.—The Empire Steel Company is planning for the immediate construction of a large new steel plant to have an initial capacity of 100,000 tons. The works will comprise a blooming mill, bar mill, tube mill, and laboratories, with a 10,000 horsepower electric plant. For the present the company will specialize in the production of seamless tubes but are planning for a general steel and iron business. John S. Long is president.

Ohio

CLEVELAND.—The Monarch Brass Company, 1621 East Forty-fifth street, has awarded a contract for the construction of a new one-story foundry, about 90x100 feet, to cost \$12,000.

CLEVELAND.—Contracts have been awarded by the Bowler Foundry Company, 1688 Columbus Road, for the construction of a new foundry building, about 75x200 feet, to cost \$40,000. The company specializes in the production of iron castings.

SANDUSKY.—The Ohio Tread, Tire & Manufacturing Company, which recently established new offices in the Lawrence Building, is planning for the construction of a large new local plant.

TOLEDO.—The Rex Spray Company, manufacturer of arsenate of lead, recently suffered a loss of about \$15,000 on buildings and \$50,000 in machinery, etc., in connection with a fire at its plant.

YOUNGSTOWN.—The Sharon Steel Company, which recently took over the plant of the Youngstown Iron & Steel Company, has acquired the furnaces of the Iron & Steel Company, Lowellville, for a consideration said to be \$3,000,000. The company is planning to increase its capital from \$10,000,000 to \$15,000,000, and is considering the construction of additional blast furnaces.

Oklahoma

PICHER.—The Producers' Mining Company is considering plans for the immediate construction of a new 300-ton concentrating plant on a 40-acre tract of lead and zinc properties recently acquired. L. V. Hivick, Oklahoma City, is president.

TULSA.—The Republic Refining Company is planning for the construction of a new 2500-barrel oil refinery at Jennings. It is said that a pipe line will be laid from Jennings to the Cushing field by way of the Quay plant, which will serve the proposed refinery.

MIAMI.—The Federal Lead & Zinc Company has awarded a contract to Henry M. Martin, Miami, for the construction of a new 300-ton plant. The company has been doing extensive development work on two of its leases, one of 20 acres and another 40 acres, and the new plant will be located on a blocked-out site on the 20-acre lease. The estimated cost is \$85,000.

Oregon

GRANTS PASS.—The Gold Hill Manganese Company, recently incorporated with a capital of \$1,000,000, is planning for the developing of its four claims on Shan Creek, six miles from Rogue River, including the installation of crushers, jig, water motor, stamp mill, saw mill, and auxiliary apparatus.

PORTLAND.—Fire recently destroyed the plate room at the plant of the Northwest Steel Company decreasing the operation of the works by about twenty-five per cent. The damage is estimated at about \$35,000. The company will commence the rebuilding at once. J. R. Bowles is president.

Pennsylvania

GLENSHAW.—The Glenshaw Glass Company has commenced the reconstruction of its one-story plant, about 75x100 and 50x100 feet, respectively, recently destroyed by fire.

PHILADELPHIA.—The Philadelphia Paper Manufacturing Company has acquired property adjoining its plant on River road in the Manayunk section for a consideration of \$25,000. It is said the new property will be used for extensions.

PHILADELPHIA.—The Nitrogenous Chemical Company is having plans prepared for the construction of a new one-story brick and concrete plant at Thirty-seventh and Tasker avenues, to be devoted to the manufacture of sulphuric acid.

PHILADELPHIA.—The United States Conditioning and Testing Company has completed its enlargement plans at its chemical laboratory, to provide for increased capacity.

HUNTINGTON.—The Aetna Explosives & Chemical Company is planning for the immediate construction of new additions to its plant at Mount Union for the manufacture of smokeless powder. The extensions are estimated to cost \$500,000. The new plant will be especially adapted for the manufacture of dyes and chemicals after the close of the war.

PITTSBURGH.—Fire recently caused a loss of about \$25,000 in the plant of the United States Glass Company, Winnebago street, South Side section, Factory A.

Texas

TOYAH.—The Toyah Texas Sulphur Company, recently incorporated with a capital of \$350,000, is planning for the immediate development of about 600 acres for the production of sulphur. A large new plant will be erected. James C. Buchanon is president.

EL PASO.—The Kansas City Smelting & Refining Company has completed extensive improvements at its local plant at an estimated cost of about \$1,000,000, including a new copper blast furnace, two new converters and new mechanical ore conveyor.

Utah

MARYSVALE.—The American Agricultural Potash Company has inaugurated operations in the second alunite potash mill of the Florence Mining & Milling Company, and two additional mills are now in course of construction.

SALT LAKE CITY.—The Standard Oil Shale Company is planning for the construction of a large new plant at Elko comprising a new refinery and a distillation re-tort with a daily capacity of about 100 tons. Professor Otto Stahlman is consulting engineer for the company.

FISH SPRINGS.—Daniel Livingston, J. A. Rich, and associates, have acquired the plant and properties of the Utah Mining Company, and are planning for the construction of a new concentrating plant.

Wisconsin

MILWAUKEE.—The George H. Smith Steel Casting Company has taken out a building permit for the erection of a new foundry and office building at Clinton street and Greenfield avenue, to cost \$50,000.

ANTIGO.—Mayer Brothers, specializing in the manufacture of power hammers, have taken over the plant of the Kaukauna Machine Works, and have filed notice of a change in its corporate name to the Kaukauna Machine Works Company.

Canada

KIRKLAND, ONTARIO.—The Teck-Hughes Mining Company is making extensive improvements in its mill to increase the capacity and improve the recovery.

PORT MOODY, B. C.—The Aetna Steel Works are planning for the installation of a new six-ton electric smelter furnace.

PRINCETON, B. C.—The Canada Copper Company is planning for the immediate construction of a new 3000-ton concentrating plant. Power for the operation of the works will be furnished by the West Kootenay Power & Light Company, Trail, which will extend its electric transmission system to this plant.

ANYOX, B. C.—The Granby Consolidated Mining, Smelting & Power Company, is making extensive improvements at its local copper mines, including the installation of new converters to increase the capacity from 75,000 to 85,000 tons per month. The company is also constructing by-product coke ovens at the plant to have a capacity of 350 tons of coke and 500 tons of coal daily. The work is estimated to cost \$1,500,000.

Trade Notes

GRASSELLI CHEMICAL EARNINGS.—The Grasselli Chemical Company reports that net earnings for the year 1917 of approximately \$4,300,000, against \$9,935,000 in 1916, \$4,859,000 in 1915 and \$1,680,000 in 1914. The stockholders have voted to approve the proposal to increase the stock to \$50,000,000, of which \$35,000,000 will be common and the remainder preferred.

GENERAL CHEMICAL EARNINGS.—The General Chemical Company saved a net profit last year of \$7,671,181 from a gross return amounting to \$11,694,686, after setting aside \$1,800,000 for Government war taxes and making substantial reservations for insurance and depreciation. In 1916 the profit was \$2,024,000 larger, although taxes then were much smaller. The surplus for 1917 after dividends had been paid was \$4,320,160, and the total surplus was \$15,719,170, against \$11,399,010 a year before.

ERICHSEN SHEET METAL TESTING MACHINE.—Herman A. Holz, 1 Madison Avenue, New York, owner of the American rights to the Erichsen patent, announces that the patent was reissued to Mr. Erichsen on Jan. 8, 1918 (No. 14,421).

MINERALS SEPARATION NORTH AMERICAN CORPORATION announce the removal of their San Francisco office and testing laboratory from the Merchants Exchange Building to 220 Battery Street, where they have established an ore-testing works.

THE ASBESTOS PROTECTED METAL CO. of Pittsburgh announces the removal of its Boston office to the State Mutual Building, to be in charge of Mr. William H. Cummings.

AMERICAN NAMES FOR AMERICAN DYES.—John Campbell & Co., 75 Hudson Street, New York, have issued a pamphlet on colors in which pertinent recommendations are made for the American dyestuff industry. The concluding part of the pamphlet says: "Every American manufacturer of dyestuffs should give to his colors an appropriate name. We should get away from the habit of referring to American colors by foreign names. In a comparatively short time we have produced colors that are equal to, and in many instances better than, the so-called German standards. It is only a question of time when the fastest, rarest, and most intricate dyes will be produced in this country.

"Now, the American consumer will never willingly put himself in the position he occupied when the war shut off the supply of German colors. He realizes the necessity of having a dependable source of supply at home, and the only way this can be done is for the consumer of dyes to support the American dyestuffs manufacturer. No American mill man should use the German trade words for the names by which he has known colors in the past. To do so would be playing right into the hands of the German business propagandist. Therefore, let us be loyal to everything American, and among other things designate the American colors by their American names."

LOW-VISIBILITY PAINTS.—The latest issue of *Graphite*, the house-organ of the Jos. Dixon Crucible Co. of Jersey City, states that commercial ships are now also painted so that they blend with misty weather and with the horizon. The company manufactures natural and olive green silica-graphite paints for this purpose.

THE HOLCROFT & LANE CO. Detroit, Mich., which has built core and mold ovens for the H. M. Lane Co., also of Detroit, has changed its name to Holcroft & Co. They will continue as a purely contracting organization and have made arrangements with the H. M. Lane Company for their engineering, consulting and drafting work. The operations of the two companies, however, have been entirely divorced, and Holcroft &

Company are now located at 555 Book Building, Detroit, Mich. The latter company also makes open-hearth and miscellaneous metallurgical furnaces.

DRIVER-HARRIS COMPANY, Harrison, N. J., on the night of Jan. 31, suffered a loss of fire of their insulated wire and electrical cord departments. These buildings have been completely destroyed. The company's business in production of resistance materials, castings, cold rolled strip, nickel sheet and other products is not interfered with.

NEW OFFICE FOR NATIONAL ANILINE.—A new office building at 21 Burling Slip, New York, will be occupied about May 1, 1918, by the National Aniline & Chemical Co., whose office at present is at 244 Madison Avenue. The new building, acquired through the Century Colors Corporation, one of the constituent companies of the National Aniline & Chemical Company, Inc., has long been known as the best equipped and most modern of dyestuffs headquarters anywhere outside of Germany. Prior to the war it was the headquarters for the distribution of dyes produced in Germany by Leopold Cassella & Company. But whereas during this period but four stories were used for office, laboratory, and clerical purposes, the National Company, together with the Century Colors Corporation, will occupy the entire ten floors for these purposes, in a thoroughly re-equipped building, with the entrance on Burling Slip. It is near the main offices of the General Chemical Company, the Barrett Manufacturing Company, the New Jersey Zinc Company, and other great chemical concerns.

FINE PLATINUM WIRE.—The Richardson Research Laboratory of Cleveland announces that it has succeeded in making a fine platinum wire to take the place of spider web for cross hairs in telescopes, etc. Platinum wire shipped to their customers recently is reported to be 0.000975 in. in diameter.

THE DURIRON CASTINGS COMPANY of Dayton, Ohio, manufacturers of Duriron, acid-alkali-rust-proof apparatus, announces the removal of its Chicago office to the Harris Trust Building, to continue in charge of Mr. George A. Cocup.

GOLDSCHMIDT COMPANIES COMBINE.—Announcement is made that the business of both the Goldschmidt Detinning Company and the Goldschmidt Thermit Company will hereafter be conducted by the "Metal and Thermit Corporation" with general offices at 120 Broadway, New York. These two concerns have been practically combined for the last two years and have occupied joint offices at the above address. The combination, which is controlled exclusively by Americans, has now been put in more permanent form as it is felt that this will tend towards greater efficiency and co-ordination of effort.

The detinning department of the Metal and Thermit Corporation will carry on one of the largest industries of its kind in the world, i. e., the recovering of tin from tin scrap. Approximately 100,000 tons of tin scrap is treated yearly by this department and the recovery approximates the equivalent of 2000 gross tons of metallic tin. The output of this branch of the corporation consists of pig tin of a quality equalling Straits tin, tetrachloride of tin and detinned billets, the latter being the iron scrap after the tin is removed.

In addition to its line of carbon-free metals and alloys, the company produces pure tungsten powder in very considerable quantity. It is also selling agent for the output of a large plant in the middle West producing 50 per cent electric furnace ferro-silicon.

The Thermit welding process is used by many of the railroads in the United States and Canada for welding broken locomotive frames and other heavy sections. It is also used very extensively by the different steel mills for welding broken equipment, such as rolls, pinions, crank shafts, etc. The process is extensively employed for the welding of rails for trolley lines, the welding of broken sternposts and rudder frames of steamships.

The Metal and Thermit Corporation operates four different plants located respectively in Jersey City, Chrome, N. J., Wyandotte, Mich., and East Chicago, Ind. The Chrome and East Chicago plants are devoted to the detinning industry; the Wyandotte plant to the production of liquid chlorine, and the Jersey City plant to the Thermit products, including welding materials, carbon-free metals and alloys and pure tungsten powder. The corporation operates branch offices and welding shops in Pittsburgh, Chicago, San Francisco and Toronto.

The following are the officers and directors: W. T. Graham, Edgar L. Marston, Daniel G. Reid, F. S. Wheeler, Hubert E. Rogers, F. H. Hirschland, E. L. Ballard, L. A. Welles, Charles F. Dane, Philipp Gensheimer, Fred W. Cohen.